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The Engineer.

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VOL. CXXXIX.—No. 3618] LONDON: FRIDAY EVENING, MAY 1, 1925 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

An Extra-High Voltage Testing Laboratory.

The British Steam Railway Locomotive from 1825 to 1924—No. 18.

Propeller-jet Marine Propulsion.

Exchange Tests of Locomotives.

New Bridge over the Niagara.

Salving the Battleship Liberté.

Southern Railway—New Single Phase Equipment.

Institution of Mechanical Engineers.

Vibration in Engine Test Gear.

Aspects of Low Temperature Carbonisation.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for—

1. COMPLETE BOILER INSTALLATION for Electric Power House, consisting of Cornish Boilers, Underfeed Stokers, Economiser, Chimney, Piping, &c.
2. WHEELS and AXLES.

Tenders due on the 19th May, 1925, for No. 1, and on the 12th May, 1925, for No. 2.
Tender forms obtainable from above. 9079

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 15th May, 1925, for RE-ARRANGEMENT of HEATING APPARATUS at the British Museum.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities, forms for Tender, &c., may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 9068

Civil Engineer, Elec- TRICAL and MECHANICAL, REQUIRED for duty in Air Ministry Works and Buildings Department, Iraq. Candidates must be ex-Service, should be not more than 36 years of age and preferably unmarried.

They should have served apprenticeship in large engineering works, had experience in construction, operation and maintenance of electrical generating plant, both A.C. and D.C., steam and internal combustion engines, pumping plant and general engineering works, with overseas experience. Must be Corporate Members of either Institution of Mechanical Engineers or Institution of Electrical Engineers. Salary £400-£500 according to experience, plus Civil Service bonus (a total salary equivalent at present rate of bonus to from £568 to £696), and foreign service allowance of Rs. 475 a month (married rate), Rs. 270 a month (single rate).—Applications should be addressed to SECRETARY, Air Ministry (W.B.5), Kingsway, W.C. 2. 9069

G. R.

For Disposal by Tender, 40,000 TONS (EX GERMAN) FLOATING DOCK No. 23.

The ADMIRALTY have FOR DISPOSAL without restriction as to use abroad the above-mentioned DOCK, lying in sections at Chatham.

Brief particulars of the Dock are as follows :—	
Lifting capacity	40,000 tons
Length overall	702ft. 9in.
Breadth	194ft.
Breadth to outside walls	183ft. 10in.
Width inside at top of walls	154ft. 2in.
Width inside at bottom of walls	147ft. 10in.
Minimum inside width (between fenders)	147ft. 2in.
Length of M.L. keel blocks	700ft.
Height of blocks	4ft. 3in.
Maximum draught of ship dockable, about	36ft.
Depth of water required at site to dock ship of 36ft. draught	63ft. 6in.
Time for lifting large ship	2-3 hours

The sections of the Dock are for sale as and where they lie and without any guarantees. Further particulars, Tender forms, conditions of sale, &c., together with an order to view, may be obtained upon application to the DIRECTOR of NAVY CONTRACTS, Admiralty, Room 62, Prince's House, Kingsway, London, W.C. 2.

Sealed Tenders are due at the Admiralty by Noon on Tuesday, the 12th May, 1925. 9021

The University of Sheffield.

ASSISTANT LECTURESHIP IN CIVIL ENGINEERING.

The Council are about to APPOINT an ASSISTANT LECTURER in CIVIL ENGINEERING. Salary £300 per annum. Further particulars may be obtained from the undersigned, with whom applications should be lodged by the 22nd May.

W. M. GIBBONS,
9040 Registrar.

PATENTS AND DESIGNS ACTS, 1907 AND 1919.

Notice is Hereby Given that GENERAL MOTORS RESEARCH CORPORATION, of the State of Delaware, United States of America, of Dayton, State of Ohio, United States of America, SEEK LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 214,580, entitled "Improvements in or relating to Bearing Materials."

Particulars of the proposed Amendment were set forth in the Illustrated Official Journal (Patents), issued on the 22nd April, 1925.

Any person, or persons, may give notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.

W. TEMPLE FRANKS,
9030 Comptroller-General.

Metropolitan Asylums Board.

TO HEATING ENGINEERS.

The Board invite TENDERS for REMOVING existing HEATING APPARATUS and PROVIDING and FIXING NEW STEAM HEATING CALORIFIERS, STEAM and CONDENSE PIPING, &c., at the North-Western Fever Hospital, Lawn-road, Hampstead, N.W. 3, in accordance with the specification and drawings prepared by Mr. T. Cooper, M. Inst. C.E., M.I. Mech. E., Engineer-in-Chief. The specification, drawings, and form of Tender may be inspected at the office of the Board, Victoria Embankment, E.C. 4, on and after 10 a.m. on Wednesday, 29th April, 1925, and can then be obtained upon payment of a deposit of £1. The amount of the deposit will be returned only after the receipt of a bona fide Tender sent in accordance with the instructions on the form of Tender and after the specification and the drawings have been returned.

Tenders, addressed as noted on the form, must be delivered at the office of the Board not later than 10 a.m. on Thursday, 14th May, 1925.

G. A. POWELL,
9047 Clerk to the Board.

PUBLIC NOTICES

City of Leicester.

STORM WATER AND SEWAGE DISPOSAL WORKS.
CONTRACT NO. 4.
CAST IRON PIPES AND OTHER IRONWORK.

The Leicester Corporation are prepared to receive TENDERS for the SUPPLY and DELIVERY of CAST IRON PIPES, BENDS, BRANCHES, SPECIAL CASTINGS, and SLUICE VALVES for RISINGS MAINS and for other IRONWORK in connection with Sewage Disposal Works.

The Contract is divided into the following sections :

Section A.—Cast Iron Pipes.
Section B.—Cast Iron Pipe Specials.
Section C.—Sluice Valves, Wall Penstocks, Floating Arms, &c.
Section D.—Automatic Revolving Sewage Distributors.

Tenders may be submitted for any or all of the items.

Copies of the conditions of contract, specification, bill of quantities, with form of Tender, &c., may be obtained at my office on and after 20th April, 1925, on payment of the sum of £2, which will be returned on receipt of a bona fide Tender.

Cheques, &c., to be crossed and made payable to the Leicester Corporation.

Sealed Tenders, together with the summary of Tender on the forms supplied, filled up and addressed to "The Chairman of the Sewage Works and Farms Committee, Town Hall, Leicester," are to be delivered not later than 9 a.m. on 9th May, 1925, endorsed "Tender for Cast Iron Pipes and other Ironwork."

The Corporation do not bind themselves to accept the lowest or any Tender.

E. GEORGE MAWBEY, M. Inst. C.E.,
City Engineer and Surveyor.

Town Hall, Leicester,
April, 1925. 9051

County Council of the County OF INVERNESS.
INVERNESS-PERTH ROAD.
CONSTRUCTION, RECONSTRUCTION AND SURFACING.
CONTRACT NO. 3.
From AVIEMORE to the SPEY BRIDGE, a Length of approximately 15¼ miles.
EARTHWORKS, BRIDGES, BOTTOMING, SURFACING, KERBS, DRAINAGE AND FENCING.

The Council are prepared to receive TENDERS for the CONSTRUCTION of the above SECTION of the Inverness-Perth Road, being the second portion of a total length of 80 miles.

Drawings and specifications, &c., may be seen on and after 1st May, 1925, at the offices of :—

The Chief Engineer, 98-102, Academy-street, Inverness ;

The Ministry of Transport, 4, Drumsheugh-gardens, Edinburgh ;

The Ministry of Transport (Roads), 7, Whitehall-gardens, London, S.W. 1.

Specification, bill of quantities, form of Tender, and all information required may be obtained on and after the same date at the office of the Chief Engineer, Major Robert Bruce, 98-102, Academy-street, Inverness, on depositing £3 3s., which deposit will only be returned on receipt of a bona fide Tender and the return of all the documents. Cheques should be made payable to the County Council of the County of Inverness.

A conveyance will be provided and an Engineer will meet contractors at Aviemore Railway Station at 8.45 a.m. on Tuesday, the 5th May, 1925, to show them over the route.

Sealed Tenders, endorsed "Tender, Inverness-Perth Road, Contract No. 3," must be lodged with the undersigned not later than Friday, the 15th May, 1925.

The Council do not bind themselves to accept the lowest or any Tender.

J. W. McKILLOP,
County Clerk.

The Castle, Inverness,
25th April, 1925. 9032

PUBLIC NOTICES

Port of Bristol.

RECONSTRUCTION OF SHED "V," BRISTOL.

The Docks Committee invite TENDERS for the RECONSTRUCTION mainly in Ferro-concrete of the Double-floor TRANSIT SHED known as Shed "V," situate on Canon's-road, Bristol.

On and after Friday, the 1st May, 1925, a copy of the form of Tender, general conditions, specification, schedule of prices, and a copy of the contract drawings can be obtained from the undersigned on production of a receipt showing that a deposit of £5 has been paid to the General Manager and Secretary of the Bristol Docks Committee, to whom all cheques must be made payable. The deposit of £5 will be returned hereafter to all bona fide tenderers.

Tenders must be enclosed in a sealed envelope, endorsed "Tender for the Reconstruction of Shed 'V,' Bristol," addressed to the General Manager and Secretary of the Docks Committee, 19, Queen-square, Bristol, and must be delivered to him, accompanied by all the prescribed documents and drawings, before 10 a.m. on Monday, the 1st day of June, 1925.

The Docks Committee do not bind themselves to accept the lowest or any Tender.

THOMAS A. PEACE,
Chief Engineer,
Port of Bristol.

Chief Engineer's Office,
Avonmouth Docks,
24th April, 1925. 8988

The Public Works Department OF THE **EGYPTIAN GOVERNMENT**

is Calling for TENDERS for

SUPPLYING, LAYING, JOINTING, and TESTING of about 11,600 Lin. Metres of 46in. diam. C.I. PIPING (Brit. Standard) between Kafr el Gamous Drainage Pumping Station and Gebel el Asfar Farm. Tenderers must have had previous experience in this work.

Tender forms, conditions, drawings, &c., to be obtained from

THE INSPECTING ENGINEER,
Egyptian Government,
Queen Anne's Chambers,
Westminster, S.W. 1.

Price £5 2s. 6d. (not returnable).
Please quote Reference No. Main Drainage 6437.
Tenders due on June 15th, in Cairo. 9034

Urban District Council of ASHBORNE.
EDLASTON-WATER-SCHEME—CONTRACT NO. 1.
TENDERS FOR BOREHOLE.

The Council invite TENDERS for the SINKING and TESTING of a BOREHOLE at Edlaston, near Ashborne, Derbyshire. The Borehole will be 24in. diameter, reducing to 18in. diameter, and is to be sunk by a rotary process to secure solid cores. The contract includes a Second and similar Borehole to be sunk only if the first proves satisfactory on test.

The general conditions, specification, schedule and form of Tender, prepared by Dr. H. Lapworth, M. Inst. C.E., Westminster, may be obtained from the undersigned on and after Monday, May 4th, on payment of £2, which will be returned on receipt of a bona fide Tender.

Sealed Tenders, endorsed "Tender for Edlaston Boring," to be sent to the undersigned not later than Monday, May 18th.

The Council do not bind themselves to accept the lowest or any Tender.

D. POWELL,
Surveyor to the Council.

Council Offices,
Ashborne, Derbyshire, 9053

PUBLIC NOTICES

TO PIPE FOUNDERS.

The Fylde Water Board Invite TENDERS from British manufacturers for the SUPPLY and DELIVERY of about 9000 TONS CAST IRON SOCKET and SPIGOT PIPES from 15in. to 36in. internal diameter, together with 230 TONS of SOCKET and SPIGOT and FLANGED SPECIALS.

Specification, quantities, &c., can be obtained from the undersigned.

The Board do not bind themselves to accept the lowest, whole of, or any Tender.

GEO. F. ATKINSON,
Engineer.

Head Office :
Sefton-street, Blackpool,
April 28th, 1925. 9049

The Madras and Southern MAHRATTA RAILWAY COMPANY, LTD.

The Directors are prepared to receive TENDERS for :—

(i.) 264 TONS WHITE LEAD ;
(ii.) 70,000 STEEL TRENAILS or CHAIR SPIKES for 80 lb. B.H. RAIL (approximate weight 53 Tons) ;

in accordance with the specifications, which may be seen at the offices of the Company. The charge for the specification for White Lead (i.) is One Guinea (£1 1s.), and for the specification for Trenails (ii.) Half a Guinea (10s. 6d.), neither of which fees will be returned.

Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, 19th May, 1925, and marked "Tender for White Lead," or as the case may be.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices :
25, Buckingham Palace-road,
Westminster, S.W. 1.
24th April, 1925. 9031

The South Indian Railway Com- PANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of—

1. POINTS and CROSSINGS, &c.
2. ELECTRIC OVERHEAD TRAVELLING CRANE.

Specifications and forms of Tender will be available at the Company's offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked, "Tender for Points and Crossings," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 22nd May, 1925.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of Specification No. 1, and of 5s. for each copy of Specification No. 2.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, of 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1.
29th April, 1925. 9061

Wigan Union.

The Guardians of the Poor of the Wigan Union invite TENDERS for the SUPPLY, DELIVERY and ERECTION of ONE ELECTRICAL VERTICAL PUMPING PLANT HEATING and DOMESTIC HOT-WATER SUPPLY APPARATUS; ALTERATIONS of BUILDINGS, ADDITIONS, and MAKING a WELL at the Poor Law Infirmary, Billinge, near Wigan.

Copies of the specification and general conditions may be obtained from me, the undersigned, on payment of a fee of £3 3s., which will be returned upon receipt of a bona fide Tender, and plans can be inspected at this office at any time during office hours.

Tenders, to be sealed and endorsed "Tender for Plant, Billinge Infirmary," to be delivered to me not later than 4 p.m. on Monday, the 25th May, 1925.

The Guardians do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
H. GORDON ACKERLEY,
Clerk.

Victoria Buildings,
King-street, Wigan,
20th April, 1925. 8972

PUBLIC NOTICES (continued) Page 2.

SITUATIONS OPEN, Page 2.

SITUATIONS WANTED, Page 2.

PATENTS, Page 3.

PARTNERSHIPS, Page 2.

AGENCIES, Page 3.

FOR SALE, Pages 4 and 108.

AUCTIONS, Pages 3 and 108.

BUSINESSES and PREMISES (For Sale, etc.), Page 3.

MACHINERY, &c., WANTED, Page 3.

WORK WANTED, Page 4.

For Advertisement Rates see Page 491, Col. 1.

INDEX TO ADVERTISEMENTS, Page 107.

PUBLIC NOTICES

The South Metropolitan Gas COMPANY has a VACANCY for an ENGINEER with wide experience in the design, construction, erection and repair of gasholders, retort and other manufacturing plant and structures of the kind used in Gas Works and Coke Oven Recovery.

Applications, giving age, full particulars of qualifications, experience, military service, and salary required, should be made in writing to the undersigned before 9th May, 1925,

By Order,
FRANK DAY,
Secretary.

709, Old Kent Road,
London, S.E. 15.
20th April, 1925. 8963

Sunderland Education Committee.
THE TECHNICAL COLLEGE.
DEPARTMENT OF MECHANICAL ENGINEERING.

The Committee invite APPLICATIONS for the POSITION of HEAD of the MECHANICAL ENGINEERING DEPARTMENT. Applicants must possess an Honours Degree and have had good drawing-office and works experience.

The standard of the full-time day courses is that required for an Honours University Degree, and that of the part-time evening courses (T.4 to T.8) is suitable for senior and advanced students from the marine engineering drawing-offices and works of the district. Experience in all types of prime movers, steam and oil, is desirable. There are courses also in advanced structures, hydraulics, &c.

Present salary scale £500-£50-£600, less 5 per cent. voluntary abatement. This scale is subject to reconsideration in view of the Burnham Award, 1925.

Application forms can be obtained from the undersigned and should be returned not later than Monday, 18th May, 1925.

HERBERT REED,
Chief Education Officer.

Education Offices:
15, John-street, Sunderland,
22nd April, 1925. 9066

Warwickshire County Council.
TEMPORARY ENGINEERING ASSISTANT.

APPLICATIONS are INVITED for the above APPOINTMENT, at a salary of £6 to £8 per week, according to experience.

Candidates must have a thorough knowledge of the Design and Construction of Reinforced Concrete Bridges, Surveying and Levelling.

The appointment will probably be for a period of at least twelve months.

Applications, stating age, qualifications, salary required, and when able to start duties, accompanied by copies of two recent testimonials, must be delivered to the undersigned as soon as possible, but not later than the 5th May, 1925.

D. H. BROWN,
County Surveyor.

County Surveyor's Office,
8, Northgate-street, Warwick,
April 22nd, 1925. 9020

SITUATIONS OPEN

BOX 8602.—ADVERTISER Begs to State that the POSITION has now been FILLED and thanks all applicants. 9061 A

WANTED, an Up-to-date ASSISTANT for WORKS MANAGER, age between 30 and 35. Must be familiar with latest Machine Shop Practice and capable of effectively reducing costs of manufacture. Factory is situated in Birmingham area. Write, stating age, experience, and salary required; all communications treated with the strictest confidence.—Address, 8981, The Engineer Office. 8981 A

WANTED, ASSISTANT to WORKS MANAGER for Heavy Structural Engineering Works near Glasgow. Must be a capable and practical man, able to control labour, a good organiser and have experience of methods of production in an up-to-date shop.—Address, stating age, experience, and salary expected, to the SECRETARY, Motherwell Bridge and Engineering Co., Ltd., Motherwell. 9052 A

WANTED by a Large Waterworks Company (in England), a SUPERINTENDING INSPECTOR—permanent employment—about 35 years of age. Must be of active habits, good address and health, thoroughly acquainted with Modern Plumbing Work, Water Fittings and Installations in large business and trade establishments, as well as in private houses, and capable of advising consumers thereon. A thorough knowledge of Waste Detection in Mains, Domestic Service Pipes and Fittings is essential. Applicants must also have a thorough mechanical knowledge of Meters and be capable of supervising repairs thereto. The applicant appointed will also be required to supervise all meter readings (2000 meters) and keep the meter books from which accounts are made out. He will also be responsible for the Company's staff of Waste Inspectors (now nine in number), meter readers, repairers, &c., and he will be required to reside on the Company's premises and take duty outside office hours alternately with the Company's Mains Superintendent and deal with complaints and breakdowns arising at such times. Salary £300, rising by yearly increments of £20 to £400, with house rent and rates free, less 5 per cent. annual contribution to the Company's Superannuation Fund, the joining of which is compulsory. Applications will only be considered from those with good experience in similar work, and these must be received not later than May 23rd next, and must be made on forms obtainable after May 2nd on application.—Address, 9041, The Engineer Office. 9041 A

WANTED by an Important Firm of Railway Wagon Builders in the North of England, a young and energetic ENGINEER, about 30 years of age, as ASSISTANT to GENERAL MANAGER.

He must have had a complete training in an important Railway Rolling Stock Contractor's Works and be able to make up estimates of railway wagons, know works costs of production, the latest methods of manufacture and be accustomed to the control of employees.

To a man having a thorough knowledge of the trade the prospects offered are exceptionally good, and all replies will be treated in strict confidence.

State age, salary expected, and when at liberty to commence duties.

Address, P574, The Engineer Office. P574 A

WANTED, WORKS MANAGER for Constructional Engineers, London district; must be thoroughly capable, reliable, and able to put work through rapidly and economically. Good salary and bonus on output. Permanent position for the right man. Only those holding similar positions need apply.—Address, stating age, experience, and salary required, 9062, The Engineer Office. 9062 A

COAL MINE MANAGER REQD., India. First-class Certificate ess. Aged 25/30, single. £480 p.a., and allowances.—Apply, LAURIE'S, Employment Specialists, 28, Basinghall-st., E.C. 2. No preliminary fee 9073 A

SITUATIONS OPEN (continued)

A VACANCY OCCURS for a Fully Qualified ENGINEER in the Manchester Office of a well-known Engineering Journal. Applicant will be required to Inspect Industrial Plant and Machinery, and to Write Descriptive Articles thereon. Full particulars as to training, experience, age and salary expected should be submitted.—Address, P570, The Engineer Office. P570 A

A WELL-KNOWN FIRM of Safe and Strong Room Manufacturers REQUIRE an ASSISTANT to their WORKS MANAGER for London. Must be fully competent, young and energetic, with good experience in D.O. and works. Good opening for suitable man.—Address, giving full particulars of experience, age, and salary required, P546, The Engineer Office. P546 A

CONSTRUCTIONAL STEELWORK. — WANTED, ASSISTANT to CHIEF of Estimating, Designing and Drawing-office; capable of Taking Charge; good technical training and knowledge of values essential. Birmingham district. State age, qualifications, salary required.—Address, 9077, The Engineer Office. 9077 A

ENGINEER REPRESENTATIVE REQUIRED for India; must have Indian experience and be familiar with Sugar Manufacture and Machinery; able to prepare estimates for plants and advise buyers; preferably unmarried. State age, experience, and salary desired.—Box No. 272, Brown's Advertising Offices, 166, Buchanan-street, Glasgow. 9028 A

ENGINEER REQUIRED for Responsible Position; must have broadest experience of Mechanical Design and Research, possess originality, be alert, hard worker, and of tactful and gentlemanly personality. Selected applicants will be subjected to a somewhat searching oral examination.—Address, P567, The Engineer Office. P567 A

ENGINEER REQD., S. America, with Exp. Permanent Way Construction. Klge. Spanish, single pref., aged 25/30. £400/450/500, qtrs., &c.—Apply LAURIE'S, Employment Specialists, 28, Basinghall-st., E.C. 2. No preliminary fee. 9071 A

ENGINEER, with Thorough Knowledge of Estimating, REQUIRED by Public Works Contractors; experience in Piling, Foundations and Reinforced Concrete essential; knowledge of Building Construction an advantage.—Address, stating age, experience, salary required and when at liberty, 9082, The Engineer Office. 9082 A

EXCEPTIONAL OPPORTUNITY FOR GOOD MAN. —ENGINEER WANTED for London, with drawing-office and shop experience in quantitative production with interchangeability and also buying experience, for placing contracts with the right manufacturers. Must be real live high-grade man, able to take responsibility. Every opportunity for advancement. Commence immediately. Salary £8 per week to start.—Write in first instance, GARRARD, 109, Kingsway, W.C. 2. P544 A

LOCO. INSPECTOR REQD., S. America. Prev. exp. Loco. Work and klgs. Spanish. Aged 28/35. £312/326/420, qtrs., &c.—Apply, LAURIE'S, Employment Specialists, 28, Basinghall-st., E.C. 2. No preliminary fee. 9072 A

OLD-ESTABLISHED LONDON FIRM of Drawing-office Material Manufacturers REQUIRE the SERVICES of REPRESENTATIVE to Manage a progressive North of England Branch.—Address, giving full particulars as to experience and salary required, 9085, The Engineer Office. 9085 A

RATE FIXER REQUIRED for General and Electrical Engineering Works; applicant must have served apprenticeship and able to pre-cost from drawings. State experience, age, salary expected.—Address, 9075, The Engineer Office. 9075 A

REQUIRED, CONTRACTOR'S AGENT, with Good knowledge of Gas and Water Pipe Laying, capable of taking full charge of new and repair work. Must be fully experienced in dealing with first-class work and a good organiser. Permanent appointment to right man.—Address applications, stating experience, salary required, and copy of testimonials, 8978, The Engineer Office. 8978 A

SHIPYARD and ENGINEERING WORKS MANAGER REQUIRED for abroad (Servia), to take full technical charge of small composite undertaking capable of considerable development. Must be a trained practical man, capable of conducting and directing Ship Repair and Construction, Mechanical Engineering, Foundry, and kindred work in all its details. A good organiser and energetic. A knowledge of German is essential.

Address, giving full resume of training and experience, salary required, &c., P487, The Engineer Office. P487 A

TRAVELLER WANTED, to Push the Sale of Grinding Wheels, with thorough experience of the business and good connection amongst users.—Address full particulars and salary expected, 9045, The Engineer Office. 9045 A

WANTED, DRAUGHTSMAN, Used to Centrifugal Pump Work, in South of England.—Address, 9070, The Engineer Office. 9070 A

WANTED, FIRST-CLASS DRAUGHTSMAN as Section Leader for Light Steel Structural Work and Conveying Plant; must be quick and accurate and capable of making all necessary calculations, and carrying out designs without supervision.—Apply, stating age, experience and qualifications, Address, "STRUCTURAL," Wm. Porteous and Co., Glasgow. P527 A

DRAUGHTSMEN.—BEFORE NEGOTIATING with Government Departments in connection with any post, PLEASE COMMUNICATE with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, London, S.W. 1. 8768 A

DRAUGHTSMEN for Cranes.—Address, Stating Age, experience, wages, when free, CHIEF DRAUGHTSMAN, John M. Henderson and Co., Ltd., King's Works, Aberdeen. 9058 A

DRAUGHTSMAN (LEADING) WANTED for Constructional Engineers' Office in Midlands; accustomed to Designing and Carrying out Contracts for Steel-framed Buildings, &c. Give fullest particulars of experience in confidence, age, wages and when disengaged.—Address, 9076, The Engineer Office. 9076 A

DRAUGHTSMAN, Skilled in Design and Lay-out of Mechanical Handling Plants for Ore and Coal. Men without actual experience need not apply. State age, experience and salary required.—Address, 9022, The Engineer Office. 9022 A

DRAUGHTSMAN, STRUCTURAL, REQUIRED by leading firm for Calcutta; age 24-30; exp. of Bridge Building and Gen. Engr. essential; able to Work-out Stresses and Design Structures. Three years' agreement. Sal. 600 r.p.m., rising; quarters, passage and all'ce.—Apply, COOPER and CO., Employment Specialists, 51-52, Carey-st., W.C. No preliminary fee. P559 A

DRAUGHTSMAN WANTED, Accustomed to Constructional Steelwork. State experience, age and salary required.—COCKSEDGE and CO., Ltd., Ipswich. P564 A

DRAUGHTSMAN, — WANTED, First - class DRAUGHTSMAN, with experience in the design of Indian Sugar Machinery. A qualified man will be liberally dealt with. State full particulars of experience, age, and salary.—Address, 8979, The Engineer Office. 8979 A

SITUATIONS OPEN (continued)

EXPERIENCED DRAUGHTSMAN, Used to Gas-works Coal and Coke Handling Plants, REQUIRED IMMEDIATELY.—Apply, with full particulars, ALDRIDGE and RANKEN, Ltd., Bath. 9087 A

EXPERIENCED FURNACE DRAUGHTSMAN REQUIRED, State experience, salary required, and when free.—Address, 9027, The Engineer Office. 9027 A

HEAD SHIP DRAUGHTSMAN WANTED by Shipbuilders in China, with actual Chief Draughtsman's experience. Technical and practical training in shipyard; used to small and medium-sized ships; aged about 40. Teetotaller preferred.—Address, fully detailing experience, P560, The Engineer Office. P560 A

LEADING DRAUGHTSMAN REQUIRED, with experience in High-pressure Impulse Turbines in the pass-out and extraction types. The position offered is for a first-class man capable of handling enquiries and complete lay-outs. Please give full particulars with experience, technical training, age, and salary expected.—Address, 9050, The Engineer Office. 9050 A

MECHANICAL DRAUGHTSMAN WANTED by Firm in London area, with first-class technical and shop training. Only men exceptionally well up in problems of mechanical design need apply.—Address, stating age, salary, and experience, 9037, The Engineer Office. 9037 A

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Limited, Trafford Park, Manchester, REQUIRE the SERVICES of DRAUGHTSMEN on Switchgear Apparatus. Neatness, accuracy and quickness essential. Electrical qualifications desirable, but not imperative.—Written applications to be addressed to EMPLOYMENT DEPT., giving particulars of training, experience and salary required. 9012 A

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For continuation of Small Advertisements see page 3

A Seven-Day Journal

Air Pollution in London.

IN the 1924 report of the Medical Officer of Health for the City of London, which was published on Monday last, some interesting figures are given concerning the pollution of the air by smoke. The rainfall along with the amounts of solid matter and soluble chemicals present in the rain-water were recorded throughout the year. In July last the deposit of solid matter which fell in the area of the City—assumed as 1 square mile—was 53.6 tons, of which 24.9 tons were soluble and 28.7 tons were insoluble substances, such as tar, carbon and grit. A daily observation was made at mid-day at the Guildhall, and the purity of the air ascertained by a dry method, which revealed the amount of suspended matter. During the year the amount of impurity at noon each day varied from ½ milligramme to 6 milligrammes per cubic metre of air, the latter figure covering foggy periods. In the course of his comments on the results recorded, the Medical Officer points out that the cost of electricity is still too high to warrant its general use for heating purposes. He suggests that the gas companies should offer advantageous terms to business premises and restaurants, to encourage them to use gas instead of coal and coke for heating and cooking purposes. Were such terms to be offered and accepted, he is of the opinion that the resulting increased purity of the atmosphere would be so marked that workers in the City would protest against the unnecessary use of raw coal, and public opinion might even be developed to the extent of assenting to the statutory prohibition of its use.

The Shipbuilding Trades' Investigation.

A FURTHER step has been taken towards instituting a joint inquiry into the economic position of the British shipbuilding industry, and a committee, representing the executives of the shipyard unions, will meet the employers' committee to-day—Friday—with a view to arranging the terms of reference of the proposed investigation. It is understood that the unions are in favour of wide terms of inquiry, and the inclusion of Government representatives, who will co-operate with the employers and unions in devising means to counter the effect of foreign competition. The inquiry will begin as soon as the questions of procedure and scope have been settled. Meanwhile, shipowners and shipbuilders who have recently returned from the Continent continue to give their personal impressions of the position. Mr. Lawrence Holt, of Liverpool, who is a competent observer, reiterates in a communication to the Press the fact that both in equipment and in technique this country still holds the lead. Indeed, for those who can afford it, a ship built in one of our good yards is, he holds, worth the 10 per cent. more which she costs. In his opinion, there is no doubt that ships can be built more cheaply in some German yards without State aid and with a margin of profit after overhead charges have been met. Some of the reasons Mr. Holt advances for this circumstance are—much smaller rates of salary and wages, the universality of piecework, longer hours, no restriction on the use of labour-saving machines, no demarcation obstacles between trades, no redundant labour in the yards, and keener work by management and workers. None of these basic causes would be removed, he thinks, by applying wartime measures of artificial stimulation to our shipbuilding industry.

The New High-power Broadcasting Station.

IT seems that, contrary to expectations, the new high-power station of the British Broadcasting Company, which is being erected at Daventry, Northamptonshire, will not be ready for service until next August. Originally, it was intended to open the station in June, but it has been found that a good deal more work will be involved in installing the apparatus than was at first anticipated. The equipment is now arriving on the site, and two masts, which are to be 500ft. high, have reached a height of 80ft. When complete, the new Daventry station will replace the experimental high-power station at Chelmsford, and it will operate on the same wave length, viz., 1600 m. The power employed will also be the same as that used at the Chelmsford station, but the Daventry equipment will naturally be of a more permanent kind.

Wages in the Engineering Industry.

ON Thursday, April 23rd, important proposals were submitted by the Engineering and Allied Employers' National Federation to the representatives of the unions engaged in the engineering industry in reply to the men's demand for a general wages advance of 20s. per week. The employers for some time have been at difference with the unions in insisting that any advance in wages must be accompanied by a modification of existing working conditions. They have therefore proposed that the day-shift week should be lengthened from 47 hours to 50 hours, and the night-shift week to 52½ hours. The existing hourly base rates of wages would be maintained, but the night shift and overtime extras would be reduced from the maxima of one-third and two-thirds to one-quarter and one-half respectively. On the other hand, the present war bonus of 10s. per week is to be increased to 12s., but the existing practice of adding the war bonus to the base rate wages for the purpose of calculating the extra allowances for night shift and overtime work is to be abandoned, the extras to be determined solely on the base rate wages. One shilling of the additional bonus is to be paid when the proposals are agreed to, and the second shilling six months later. The employers' proposals were accompanied by a statement of the grave difficulties which the British engineering industry has now to face. The union executives, it seems, expressed strong views regarding the employers' proposals, but it was ultimately decided to submit them to the unions for consideration, and to adjourn the conference until May 20th.

Railways and Road Traffic.

HAVING failed some time ago to secure statutory right to convey traffic by road, the railway companies would seem to be becoming more and more alarmed at the growing menace of road competition. They have for long urged the unfairness of the circumstances that, while they as common carriers are compelled by law to take whatever traffic is offered them, their competitors on the roads are in a position to pick the best paying loads and to neglect the rest. In a renewed statement of the case a prominent railway official gives us some interesting figures bearing on the matter. On road maintenance and construction some 45 to 50 million pounds per annum are, it is stated, being expended, of which sum about one-third is contributed by the owners of road motor vehicles and two-thirds by the ratepayers. The railways, it is urged, are the largest ratepayers in the kingdom, their total contributions amounting to nearly eight millions a year. Yet they are not allowed to use the roads for the general carriage of goods. On the contrary, they have to expend about 25 millions a year on the maintenance and renewal of their tracks. Again, the cost of acquiring the land and building the lines represents a sum of about 900 million pounds, all of which has been contributed by private enterprise. A very similar sum represents the estimated cost of the roads and road bridges of the British Isles, but in this case—so it is stated—the money has been entirely found by the ratepayers. The road carrier, it is argued, is thus being subsidised by the provision of a free road, and a contribution of some 30 millions annually from the ratepayers towards maintenance. Even his signalling, in the shape of a policeman, is provided free of charge. If the railways could be relieved of the capital cost of their road and of two-thirds of the cost of its maintenance, they could, it is argued, greatly reduce their rates for the carriage of passengers and goods.

Electricity Supplies

IT is well known that the Government has under consideration an important scheme for linking up existing electricity supply undertakings and for reducing the cost of current. Consideration of the question has, however, occupied more time than was originally anticipated, and legislation on the subject will, it seems, have to be postponed until next year. A small committee, presided over by Lord Weir, will, nevertheless, be in a position in about three weeks' time to present a comprehensive report on the development of the supply of electricity in this country to the Minister of Transport, Lieut.-Colonel Wilfred Ashley. In ministerial circles the view is apparently held that as the problem is one of considerable complexity, the delay may prove advantageous, as a more thorough investigation of the question will be possible. An important step in connection with increasing the use of electricity is the formation of a committee by the Electricity Commissioners, under the chairmanship of Mr. J. W. Beauchamp, which, as we have previously stated, will include representatives of three important associations, and will consider, among other things, what methods can be adopted to popularise the use of electricity for domestic purposes.

Power Alcohol from Sugar Beet.

TO operate a beet sugar factory on an economic basis requires, it is stated, the command of a minimum daily supply of 1000 to 1200 tons of beet. Such a quantity can only be obtained from a large area extending from 15 to 20 miles from the factory. It follows, therefore, that beet sugar factories cannot profitably be established in many small areas, which otherwise are suitable for the growing of beet. On the other hand, a factory for the production of power alcohol from beet can, it is said, operate economically on a supply of 200 to 250 tons of beet daily. The British Power Alcohol Association, a body presided over by the Earl of Denbigh, and affiliated with the British Empire Producers' Organisation, is interesting itself in the establishment of small unit distilleries in all parts of the country where the erection of beet sugar factories would be uneconomical. To further that end it is seeking to secure from the Government the same subsidy for beets grown for the production of power alcohol as is now accorded under the British Sugar (Subsidy) Bill of 1924 to beets grown for sugar. The Association believes that with assistance of this nature in its earlier stages the industry in a few years would be able to supply from 30 to 40 per cent. of the country's present motor fuel requirements.

Re-Modelling a London Station.

IT is just sixty years ago since the City extension of the Charing Cross Railway, as the South-Eastern's line from London Bridge across the Thames to the Cannon-street terminus was first called, was opened for service. At the same time a junction with the line from London Bridge to Charing Cross was made so that traffic could pass direct from the West End station to the City without touching London Bridge. The result was the creation of a triangle of lines on the Surrey side which by some is held to be one of the most dangerous spots in the British railway system. Until a few years ago the South-Eastern, much to the annoyance of many of its passengers, persisted in running many of its suburban trains into Cannon-street, reversing them and then taking them on to Charing Cross. To-day it operates its trains either into Cannon-street or Charing Cross, and has abandoned the tedious and expensive reversed working. One side of the triangle has thus become practically useless and, with the near approach of the completion of the Southern Railway's electrification scheme, it is proposed, we learn, to take it up and discard it. The whole track system outside Cannon-street Station will, as a result, be capable of being greatly simplified, to the relief no doubt of all concerned. The work will present considerable difficulty, so much so that it is intended to put down the new track experimentally at New Cross and test it thoroughly before laying it in its final quarters. It will be necessary to close Cannon-street Station half at a time for some six weeks, and traffic will, as a consequence, be considerably interfered with. The opportunity will be taken to re-model the whole of Cannon-street Station with the exception of the roof. This work will involve an expenditure of £168,000.

Japanese Shipbuilding Feat Recalled.

THE Japanese steamer Raifuku Maru, which foundered in the North Atlantic recently with all hands, while carrying a full cargo of grain, was a historic ship, though the fact appears to have escaped notice. During 1918 the insatiable demand for tonnage encouraged Japanese shipyards to build up to their utmost capacity, and the Kawasaki Dockyard laid down a whole fleet of cargo steamers to a standard design. These vessels, of which the Raifuku Maru was one, were of 5857 tons gross and 9095 tons deadweight, the length being 385ft., the beam 51ft., and the moulded depth 28ft. All were built very rapidly, but in the case of the Raifuku Maru a special effort was made, and her launch took place exactly twenty-three days after the laying of the keel plate. This achievement is thought to be without parallel in the history of shipbuilding. The distinction of having broken the world's record for speedy construction is sometimes claimed by the United States, for in 1918 the steamer Crawl Keys was put afloat twenty-nine days after the keel had been laid. This vessel, however, besides being six days longer on the slipway, was of 3000 tons deadweight only, or less than one-third the size of the Raifuku Maru. There are no grounds for assuming that the rapidity with which she was built affected the quality of the work put into the Japanese ship, which up to the date of her loss had proved herself seaworthy in all respects.

A New Target Ship.

WE understand that the battleship Agamemnon, which has served for the past three years as target ship to the Atlantic Fleet, is about to be paid off, and will be replaced by the Ajax, a vessel of much later and more powerful design. The selection of a comparatively modern battleship of the "Dreadnought" type for target duty testifies to the importance with which gunnery experiments are now regarded by the Admiralty. Compared with several of the capital ships which the United States, France and Italy are retaining in their post-Treaty fleets, the Ajax is larger, more heavily armed, and better protected, and but for the Washington Agreement she would certainly have remained on the active list for years to come. The conditions under which target ships are fired at are, of course, confidential, but the fact that the Agamemnon has survived repeated bombardments is proof that care is always taken to avoid inflicting fatal damage. The sinking of the Monarch earlier in the year was intentional, as that vessel had to be eliminated by a given date in accordance with the Washington Treaty. The value of gunnery tests against modern target ships is too obvious to need emphasis. It was largely because of their close attention to this branch of research that the Germans were able to endow their capital ships with such remarkable defensive qualities, albeit at the expense of other features, such as speed and habitability. Since the Ajax would in any case have had to be discarded as soon as the Nelson and Rodney are commissioned, the Admiralty has acted wisely in preserving her to fulfil a non-combatant but highly important *rôle* in the training of the Fleet.

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. XVIII.*

LOCOMOTIVE PERFORMANCES, SPEEDS, AND COKE CONSUMPTION.—1845 to 1859.

FROM the opening of the Liverpool and Manchester Railway in 1830 until the end of 1845, there were plenty of records by Pambour, Whishaw, and in the Gauge Commission evidence, from which speeds and performances could be analysed. These have already been briefly mentioned. Subsequently a certain amount of similar information covering the period 1845 to 1853 is also available, derived principally from experimental trials, some of which were stimulated by the gauge controversy. Much of it was recorded by D. K. Clark in "Railway Machinery." But during the period from 1853 until about 1876 there is hardly any information whatever. Very few experiments appear to have been made, and these, with the exception of coal-burning trials, mostly with goods engines, were not at the time considered of sufficient interest for publication. The greatest void is the absence of authentic speed records of express trains of known weights. No train-timing enthusiast, such as the late C. Rous-Marten, appears to have existed, and the very few records which found their way into print appeared in the daily Press and were mostly either inaccurate or mythical.

G.W.R. Broad Gauge.—In August, 1847, trials were made with the eight-wheeled 8ft. single engines—"Great Britain" class—with 18in. by 24in. cylinders, from Paddington to Swindon and back—154½ miles. Weight of engine and tender, 50 tons.

	Great Britain.	Iron Duke.
Average speed for six double journeys, miles per hour	51	53.4
Average speed for best double journey, miles per hour	54.5	56.7
Gross average load, engine, tender and train, tons	103.5	105
Coke per mile, average, lb.	34.4	36.6
Total water per pound of coke, lb.	8.23	8.4
Temperature of water in tender, deg.	109	91
Coke fired per square foot of grate per hour, lb.	83.6	93.1

The rate of firing was not given by D. K. Clark, but has been calculated by the writer from the available data. The total water per pound of coke does not represent the equivalent evaporations from and at 212 deg. Unfortunately, the actual boiler pressures were not stated, but on the basis of a working pressure of 100 lb., these equivalent evaporations would be:—Great Britain, 9.4, and Iron Duke, 9.9 lb. per pound of coke.

One of the first things likely to occur to the modern observer is the heavy coke consumption per mile on a very easy road as regards curves and gradients with light trains weighing 53½ to 55 tons behind the tender. As a result of experiments on other railways Clark—"Railway Machinery," page 316—stated that "with equal weights of coke and coal, coke is capable of evaporating 50 per cent. more water than coal, their mechanical values being in the ratio of 2 to 3."[1] Based on these figures the coke consumption of the Great Western engines was equivalent to rates of 51.6 lb. to 54.9 lb. of coal per mile with exceedingly light trains. These figures are manifestly absurd. The 2 : 3 ratio appears to have been derived as a result of early coal-burning trials, either with fuel of poor quality or in small coke-burning fire-boxes unsuitable for coal. In the early attempts at coal burning the hydrocarbons were not properly consumed, and coated the inside surfaces of the tubes with soot, a bad conductor of heat. This may partly account for Clark's ratio. Further, Edward Woods stated[2] that in the trials with McConnell's engines, the Hawkesbury coal used contained only 67 per cent. of carbon, whilst the coke contained 94 to 96 per cent.

M. Perdonnet (Chemins de Fer, 1865) pointed out that on the Eastern Railway of France the weight of coal compared with that of coke consumed in the same fire-boxes was in the ratio of 14 to 10, which is not far from Clark's figure, but he added that the coal burnt was very impure and that the coke had been produced from washed coal.

The writer travelled a great deal on the footplates of the G.W.R. 8ft. single engines between London and Newton Abbot, a few years before the abolition of the broad gauge, when the Welsh coal consumption was about 28 lb. to 32 lb. per mile with average train loads of 120 to 130 tons, or about double the weight of those in the 1847 experiments. The general dimensions of the later engines differed only slightly from those of the 1848 period, but the boiler pressure was higher.

One reason given for the high coke consumption of 1848 was that the grates and fire-boxes were too large for coke burning. Clark stated that in subsequent trials in 1849 with similar engines, six of the "Great Britain" or "Iron Duke" class, with 21 square feet grate area, 142 square feet fire-box, and 1769 square feet total heating surface, evaporated 7.69 lb. of water per pound of coke, whereas seven of the similar "Courier" class, but with 23.6 square feet of grate area, 149½ square feet of fire-box, and 1739½ square feet of total heating surface, evaporated only 7.19 lb. of water per pound of coke, the average loads and speeds being practically the same as those in the earlier trials. These heating surfaces are those given by D. K. Clark, who in nearly all cases estimated them on the "fire-side." The actual water-side surfaces were:—"Iron Duke" class, fire-box 147.87, total 1945 square feet; "Courier" class, fire-box 162, total 1919 square feet. The fire-boxes had transverse midfeathers. The figures 7.69 lb. and 7.19 lb. for "evaporation" were the amounts of water actually used. As subsequently given by the same author, they were 9.17 lb. and 8.6 lb. respectively, from and at 212 deg. The coke burnt per square foot of grate per hour was 90 lb. for the "Great Britain" class and 75 lb. for the "Courier" class. The maximum boiler pressure at the time of the trials was 100 lb., but was subsequently raised to 115 lb. to 120 lb. The blast pipe orifice, which was placed only 2in. below the crown of the smoke-box, was stated by Clark[3] to have been 5½in. diameter. This was Tredgold's outside measurement, and the actual orifice during some of the trials was 5in.[4]

Though with thick coke fires a gas producer action would occur and loss might result from the formation and escape of CO, it is hard to believe that this action took place in the case of the G.W.R. engines with their extremely large grates, unless the transverse partition tempted the fireman to maintain too thick a fire in the back compartment of the fire-box. This was certainly one of the defects of such partitions, which in these G.W.R. engines were so high that it was hardly possible to fire the front compartment properly. Clark pointed out that these engines had too many tubes packed together with but ¼in. clearance, and that this was one of the causes of the inferior evaporative results. There were 303 2in. tubes in a barrel 4ft. 7¾in. inside the smallest ring. In the reconstructed engines of 1870 to 1876 the tubes were reduced to 1⅝in. diameter, and in some cases to 1½in., but 369 to 377 of them were contained in a barrel of practically the same diameter. The transverse fire-box partitions were discarded, and the boiler pressure was raised to 140 lb. The spaces between the fire-bars, which in the old coke-burning engines had been 1¾in., were reduced to about ¾in. in the coal-burning type. These are the engines of which the actual coal consumption in later years is referred to above, and, of course, the increased pressure must be taken into consideration when making comparisons.

The broad-gauge 8ft. single engines from 1847 until about 1880 undoubtedly performed the fastest running in the country. In 1848 the 9.50 a.m. from Paddington arrived at Swindon (77¼ miles) in 85 min. with an intermediate stop at Didcot, and the run from the start to the latter station, then 53 miles, must have been performed in 56 min. if time were kept. In this connection there was a story current for many years that the Great Britain had on May 11th, 1848, covered the 53 miles in 47½ min., start to stop, the average speed being 66.9 miles per hour. It is just within the bounds of possibility that this may have been done with one of the very light trains of those days, but there is no authentic confirmation[5] of the performance, which was never repeated. What makes it somewhat doubtful is the softness of the iron rails of those days, and the low moment of inertia of the light rail sections, in addition to which the effect of an almost continuous, though very slight, rising gradient has to be taken into consideration.

Mr. Charles Sacré, afterwards chief locomotive engineer of the M.S. and L. Railway, was present at the trials in 1847–9 of the 8ft. singles, and many years afterwards told Mr. Rous-Marten that the maximum speed which could be obtained down the Wootton-Bassett bank of 1 in 100 was just over 78 miles per hour. Pearson's Bristol and Exeter 9ft. double-bogie tank engines are stated to have attained 81.8 miles per hour down the Wellington bank of 1 in 81. If this latter speed was actually attained it probably remained a record for more than thirty years.

Standard-gauge Engines.—In May, 1848, the Midland Railway made a trial between the two standard 2–2–2 engines, one a "Jenny Lind," by E. B. Wilson and Co., and the other one of Sharp Bros.' engines.[6] Each engine ran a train consisting of nine carriages and two vans from Derby to Masborough. Both engines were almost new and the test was made to ascertain which was the better for fast trains.

The line rises to Clay Cross (20 miles) at an average gradient of about 1 in 330 and then falls similarly for the remaining 20 miles. Therefore, comparing the figures with those of the Great Western "Iron Duke" and "Courier" classes, the "Jenny Linds" show better results, for not only was the road harder, but the trains were heavier, though the gross loads were almost the same. The coke consumptions are, as in the case of the G.W. engines, high, but it would seem that the trials were somewhat in the nature of a race to see which engine could "get there first," and probably more coke was burnt than would otherwise have been the case.

In these engines the fire-boxes and grates were of very moderate dimensions, and the high coke consumption appears to have been due to the forcing of the boilers, and much unburnt carbon monoxide, and probably coke also, must have been pulled through the tubes. The Wilson engine with 11ft. tubes evaporated more water per pound of coke than the Sharp engine with 10ft. tubes. In a second trial with heavier loads of seventeen carriages, weighing 99.8 tons behind the tenders, the respective quantities of water used were approximately 7¼ lb. and 6 lb. per pound of coke.

As regards loads and speeds combined, these performances were certainly the best on record of that day. With a net load of 100 tons the Wilson engine passed the eighteenth milepost from the dead start in 20 min. 19 secs., and the Sharp engine in 27 min. 55 sec., the gradient being uphill the whole way. The superiority of the Wilson engine was almost entirely due to the much higher pressure—120 lb. per square inch.

The following are the published figures, to which the writer has added the data marked †:—

	Wilson's Jenny Lind.	Sharp's engine.
Cylinders	15″ × 20″	16″ × 20″
Diameter of driving wheels	6′	5′ 6″
Boiler tubes	124	161
	2″ × 11′	2″ × 10′
Heating surface—Tubes	720 sq. ft.	847 sq. ft.
Fire-box	80 ,,	72 ,,
Total	800 ,,	919 ,,
Working pressure	120 lb.	80 lb.
Weight of engine, loaded	24 t. 1 c.	21 t. 9 c.
Weight of tender, loaded	15 t. 13 c.	12 t. 11 c.
Weight, total, loaded	39 t. 14 c.	34 t. 0 c.
†Tractive force per lb., m.e.p.	62.5 lb.	77.58 lb.
†Tractive force at 65 per cent. boiler pressure	4876 lb.	4034 lb.
†Tractive force at 35 per cent. boiler pressure	2625 lb.	2172 lb.
†Weight on driving wheels	10 tons	9.1 tons
Weight of train	64 tons	64 tons
Gross weight, engine, tender and train	103 t. 14 c.	98 tons
Time from start to stop	46 m. 32 s.	50 m. 10 s.
†Average speed throughout	51.9 m.p.h.	48.1 m.p.h.
Maximum speed	59 m.p.h.	58.5 m.p.h.
Coke consumption	13 cwt.	16 cwt.
Coke per mile	36.2 lb.	44.5 lb.
†Coke per gross ton-mile	.35 lb.	.45 lb.
†Coke per net ton-mile	.56 lb.	.69 lb.

The coke consumptions were given only to the nearest hundredweight, and therefore all figures involving them can only be approximate.

In February, 1848, a very light special newspaper express from London (Euston) to the North was worked by Midland engines of the above-named classes. From Rugby to Derby the Sharp engine ran through at an average speed of 52.5 miles per hour. A Wilson "Jenny Lind" took the train on from Derby to Altofts Junction, north of Normanton, 63¾ miles, in 68 min., the average speed being 56.1 miles per hour. This train was arranged by W. H. Smith and Son to convey copies of *The Times* containing Lord John Russell's Budget speech of February 18th, 1848, from London to Glasgow. Leaving Euston at 5.35 a.m. on the 19th, it reached Wolverton, 52¾ miles, in exactly one hour, and from Wolverton to Rugby the average speed was 51.4 miles per hour. The writer does not know what type of L. and N.W.R. engine was used, but in all probability it was one of the long boiler Stephenson rear-driver single engines, as these were the only express engines then available. On the lines north of Normanton (Altofts Junction), afterwards the N.E.R., the average speed was about 50 miles per hour. The train reached Glasgow, *viâ* Newcastle and Edinburgh, in 10 h. 22 min., the net *running* time for the 470¾ miles being 9 h. 32 min.[7]

In April, 1847, Stephenson's three-cylinder engine, at that time of the long boiler type with rear driving wheels, was tried on the L. and N.W.R. and worked a special express weighing about 30 tons from Wolverton to Birmingham. The run from Wolverton to Coventry, 41½ miles, was stated to have been performed in 42 min.[8] This engine was sold to the York, Newcastle and Berwick Railway, and W. W. Tomlinson[9] records that it "took the Royal train from Berwick to Newcastle at an average speed (excluding a stoppage of 5 minutes) of 57 miles per hour. The writer is inclined to believe that some error in this figure occurred at some time or other, since the objection of H.M. the late Queen Victoria to high speeds was well known.

Some particulars of an early run in August, 1845, of a light special express from Sunderland to London (Euston) *viâ* Derby and Rugby were given in THE ENGINEER of September 1st, 1905.

Of the performances of the L. and N.W.R. engines, including McConnell's "Bloomers" (7ft.) and

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* No. XVII. appeared April 24th.

[1] See also "Railway Machinery," page 123.

[2] "Proc.," Inst. C.E., Vol. XVI. Discussion on D. K. Clark's paper "On the Improvement of Railway Locomotive Stock."

[3] "Railway Machinery," page 130.

[4] Tredgold's "Steam Engine," 1852 edition, Table XIII., page 61.

[5] Nearly forty years afterwards the writer often talked to the fireman of the Great Britain during this run, who always maintained that it had been done as recorded, but as he was about sixty-five to seventy years of age when the conversations took place, his evidence is of doubtful value.

[6] These trials are not mentioned by D. K. Clark, but he gives other comparative trials between similar engines on the M.S. and L.R. at considerably lower speeds ("Railway Machinery," page 314).

[7] There were delays at Newcastle and Berwick in conveying the papers across the rivers, as the High Level and Border bridges were not then opened. Full details of this run appeared in THE ENGINEER, July 6th, 1900, page 16.

[8] *The Times*, April 29th, 1847; the *Railway Chronicle*, May 8th and 15th, 1847.

[9] "The North-Eastern Railway: Its Rise and Development," page 539.

300 class (7ft. 6in.), the latter with combustion chamber, as well as the small Allan type Crewe engines, a very full record is given in the exhaustive report of Edward Woods and H. P. Marshall as a result of experiments made by them during February and March, 1853. The most important particulars were fully summarised by D. K. Clark ("Railway Machinery," pp. 314–316) and are too long for detailed analysis here. Suffice it to say that in the trials between the 7ft. "Bloomer" No. 291 and the Crewe engines the following average results were obtained from the first five experiments, in which only these two classes were concerned :—

	7ft. McConnell Bloomer No. 291.	6ft. Crewe engine, "Heron" class.
Mean net train load (seventeen carriages), tons	86	86
Mean gross load, including engine and tender, tons	132	115
Mean speed, miles per hour	34.27	33.67
Mean maximum speed, miles per hour	50	45.4
Coke per ton-mile of train load only, lb.	.357	.344
Water evaporated per pound of coke, lb.	6.75	7.54
Coke per mile, lb.	28.08	27.13

No. 291 had 16in. by 22in. cylinders and those of the Crewe engines were 15in. by 20in.

One important point is not mentioned, and appears to require explanation. McConnell's engines were constructed to work at 150 lb. boiler pressure. During the trials they were pressed at 120 lb. and 130 lb. to correspond with the pressures carried by the Crewe engines. This fact appears to the writer to vitiate comparison between the engines as actually designed and intended for service.

In all the cases previously mentioned the coke consumption was probably greater than the average, for

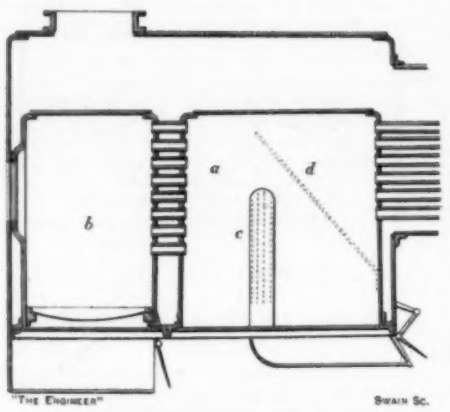


FIG. 133—DEWRANCE'S FIRE-BOX, 1845

D. K. Clark gives instances in regular practice in which the coke consumption was 18 lb. to 25 lb. per mile, and in some trials of J. V. Gooch's main line tank engines on the Eastern Counties Railway it was as low as 15 lb. to 15½ lb., with trains of 45½ to 68 tons at a mean speed of 38 miles per hour.

When coke-burning boilers were "forced" the long boiler appeared to advantage. "The method of extending the heating surface by increase of length, whether in the fire-box or tubes, but especially in the latter, is consistent with the soundest practice, and Stephenson's long boiler was in all respects a decided advance upon previously existing examples."[10]

COAL BURNING IN LOCOMOTIVES.

Locomotive Fuel, 1825 to 1850.—The early Stockton and Darlington engines were coal burners. This fuel was cheap and obtainable from the collieries served by the railway. The large furnace volume of the flues, more especially in the case of the return-flue boilers, materially assisted the process of combustion. The areas of the flues were large and the velocity of the gases comparatively slow, so that time was allowed for the gases and air to become mixed. The evaporation *per square foot of heating surface* was considerably higher than that of the later multitubular boilers. Much of the smoke was consumed, though a considerable amount must have been emitted, since we find a clause in the Act for the Liverpool and Manchester Railway which prohibited the emission of smoke. In 1828 George Stephenson was experimenting with the Lancashire Witch and Twin Sisters locomotives to solve the problem of coke burning. Although coal was not prohibited, the result of the Act was that from 1829 coke for many years became the universal fuel on main line railways other than the Stockton and Darlington and one or two other lines in the Durham area.

The early multitubular boilers with their small fire-boxes and grates and short tubes were unsuitable for bituminous coal burning, in that there was insufficient grate area and fire-box volume and inadequate time for proper combustion. The early experimental attempts to overcome these difficulties took the forms of (1) providing special means for increasing the air supply above the fuel, (2) the addition of some form of combustion chamber between the fire-box and the tubes, and (3) increasing the length of path of the gases inside the fire-box by means of complicated bridges, generally in the form of water "pockets," which deflected the gases downwards on to the fire before they entered the tubes. This last method added a certain amount of heating surface, of doubtful value, but was detrimental in that the space occupied reduced the fire-box volume, thereby increasing the velocity of the gases and consequently decreasing the time for combustion. It is unnecessary to describe most of these systems in detail; many of them were illustrated in Clark and Colburn's "Recent Practice in the Locomotive Engine" (1860), beginning with Gray and Chanter's early fire-boxes of 1837–9 and ending with Alexander Allan's and D. K. Clark's systems of 1857–8. With the exception of Clark's most of them were characterised by extreme complication and a multiplicity of awkward joints, which, whatever the merits of the systems as efficient coal burners, ultimately condemned them on account of heavy fire-box repairs.

In one of Chanter's fire-boxes, not described in the work mentioned above, there were three vertical brick partitions between which the gases and air passed on their way to the tubes.[11] But the most interesting feature of this design, which was tried in 1841 or 1842 between Birmingham and Derby, was the use of transverse water tubes extending from side to side in the fire-box and supporting the brick partitions. In this we have what is probably the first example of *fire-box* water tubes above the grate.[12]

Hall's System. — The earliest arrangement which appears to have been successful in consuming smoke was that of Samuel Hall, of Nottingham. It was applied to a small four-wheeled engine Bee on the Midland Counties Railway in 1841. It was originally entirely an air admission system, in which sixteen of the lower boiler tubes were prolonged to the outside of the smoke-box door, where they were bell-mouthed to catch air which was conveyed through the boiler to the fire-box. Eight additional air tubes were inserted through the sides of the casing and fire-box. A steam jet or blower was provided in the chimney for use when the engine was standing. A brick arch was also fixed in the fire-box,[13] though this seems to have been a subsequent addition after the engine had been working a short time. The blower may be considered to have been an adaptation of Nicholson's steam jet of 1806, but the brick arch for deflecting the gases appears to have been entirely new. The plan was abandoned, chiefly owing to the smoke-box becoming red hot. With its disappearance locomotive engineers lost sight of the value of the brick arch for about fifteen years. Hall's system seems to have cropped up from time to time in later years. D. K. Clark wrongly ascribed it to Edward Wilson on the Oxford, Worcester and Wolverhampton Railway in 1858.[14]

Hall appears to have been the first originator of the idea of the brick arch, though the late Mr. Bowen Cooke[15] ascribed it to a driver on the London and Birmingham Railway, who built a block of bricks in the fire-box as a sort of heat reservoir. This was a failure, and the block was converted into an arch by removing the middle portion. The date was not mentioned, but was probably later than Hall's arrangement.

Dewrance's Double Fire-box.—In 1845 the Liverpool and Manchester engine Condor was constructed to John Dewrance's design with the double fire-box shown in Fig. 133.[16] The back box with the grate bars was the fire-box proper and was connected with the front box or combustion chamber *a* by a series of tubes. This was the first system in which the value of fire-box volume for coal burning appears to have been recognised. Air was admitted from a front damper through a series of vertical perforated tubes *c* in the combustion chamber, which was otherwise air-tight at the bottom. A subsequent addition of an inclined deflector plate *d* was made to increase the length of path of the gases. The engine was stated to have performed satisfactorily as regards coal burning, but the use of the system was never extended.

Air Inducing Steam Jets.—In 1845 Messrs. Hawthorn supplied an engine to the Eastern Counties Railway, in which a series of steam jets near the fire-door injected air, which was brought through a pipe. The steam and air were blown downwards on to the surface of the fire, and a second row of steam jets placed along the top of the fire-box tube plate deflected the smoke and gases downwards before they entered the tubes. The idea was subsequently developed by D. K. Clark.

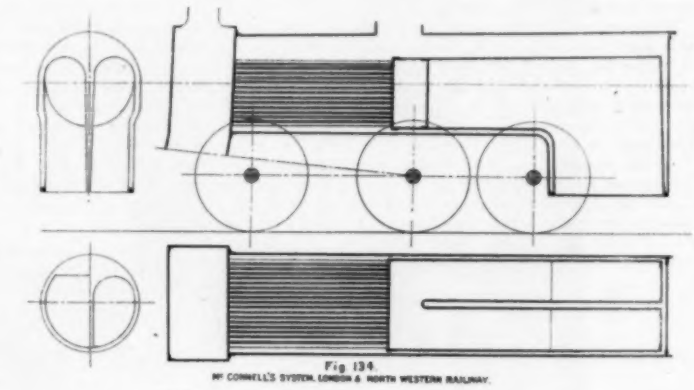


Fig. 134.
McCONNELL'S SYSTEM, LONDON & NORTH WESTERN RAILWAY.

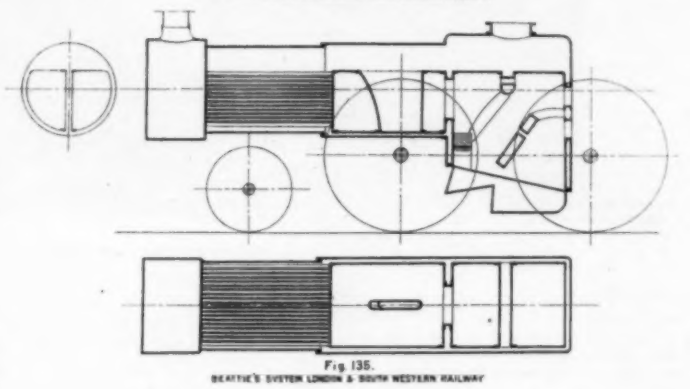


Fig. 135.
BEATTIE'S SYSTEM LONDON & SOUTH WESTERN RAILWAY

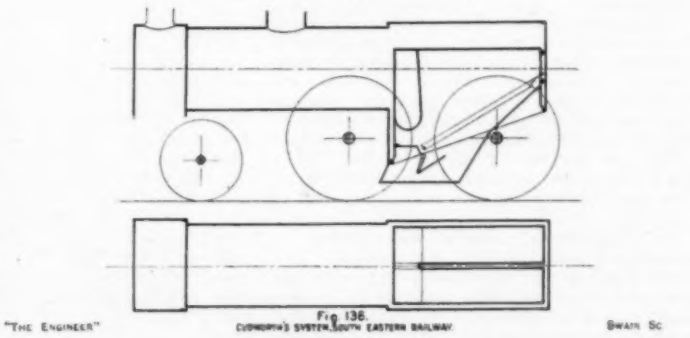


Fig. 136.
CLEMENTS'S SYSTEM, SOUTH EASTERN RAILWAY.

FIGS. 134 TO 136—COAL BURNING FIRE-BOXES

J. E. McConnell's Boiler.—McConnell's boiler of 1852–3 is shown in Fig. 134. Its outstanding features were very large grate[17] and fire-box volume, the latter obtained by extending the upper part of the fire-box into the barrel, thus forming a combustion chamber. The fire-box and chamber were divided into two separate compartments by a longitudinal partition with water space between, and therefore two firedoors were necessary. In the earlier examples each compartment had a vaulted semicircular roof, as in Hawthorn's 1839 patent. The front portion of the barrel contained 305 1¾in. tubes 7ft. long in the case of the express engines (Fig. 88 *ante*), although the boiler diameter was only 4ft. 3¼in. outside.

The principle of the combustion chamber was good and has since been extensively used in modern American practice, but the dimensions and details

[10] D. K. Clark, "Combustion of Coke in Locomotive Fire-bcxes," "Proc.," Inst. C.E., Vol. XII., 1853.

[11] "Proc.," Inst. Mech. E., 1860. Markham on "Coal Burning in Locomotives."

[12] A water-tube grate was used in Stephenson's S. and D.R. Experiment of 1826 or 1827—see Warren, pages 120 and 133. T. Hackworth's Globe of 1830 had transverse water tubes in the flue, somewhat similar in principle to those of Galloway's later stationary boilers.

[13] Markham, "Proc.," Inst. Mech. E., 1860.

[14] Clark and Colburn, "Recent Practice in the Locomotive Engine," page 30, and Colburn's "Locomotive Engineering" page 296.

[15] "Proc.," Inst. Mech. E., March, 1908, page 350.

[16] From Clark and Colburn's "Recent Practice in the Locomotive Engine."

[17] The illustration shows a long boiler engine with overhanging fire-box and consequently short grate. The express engines had grates varying from 5ft. 10½in. in the earlier to 7ft. long in the later examples.

were faulty. In spite of the extra complication the evaporative power was poor. On the other hand, the coal burnt was much cheaper than coke, and there was absence of smoke. To cram 305 1¾in. tubes into the barrel was a mistake and impeded free giving off of the steam. The combustion chamber appears to have been too long in relation to the tube length and the steam space was very restricted. The top of the vaulted roof of the fire-box was too far from the grate. McConnell stated ("Proc.," Inst. C.E., Vol. XII.) that by placing the tube plate some distance within the boiler the tubes were not liable to be choked with cinders, and this made it possible to reduce the tubes from 1¾in. to 1⅝in., "giving in the same boiler an equal flue area with a increased proportion of tube heating surface." (?) He also gained a large addition of flame surface.

The above-mentioned reduction of tube diameter from 1¾in. to 1⅝in. is not borne out from either the Wolverton official records or McConnell's own specification of the 7ft. 6in. express engines, 300 class. Nearly all his engines, both passenger and goods, had 2¼in. or 2⅛in. tubes, but in those with long combustion chambers the tube diameter was 1¾in., the smallest size recorded at the time when he made this statement. Probably he was speaking from memory, and meant a reduction from 2¼in. to 1⅝in.

Although the boilers were coal burners, they were also used for coke, and in Woods and Marshall's trials of engine No. 300 (D. K. Clark, "Railway Machinery," p. 315) coke was the fuel used. As coke burners they were not successful, the smoke-box temperatures being exceedingly high, and were said to have reached 1100 deg. to 1200 deg. Fah.

In his later boilers of 1862 McConnell compromised by shortening the combustion chamber, reducing the tubes to 214 and lengthening them to 9ft. 4in., though their diameter was increased from 1¾in. to 1⅞in. Even in this case the tube spaces were only ¼in. The double fire-box with longitudinal partition was retained.

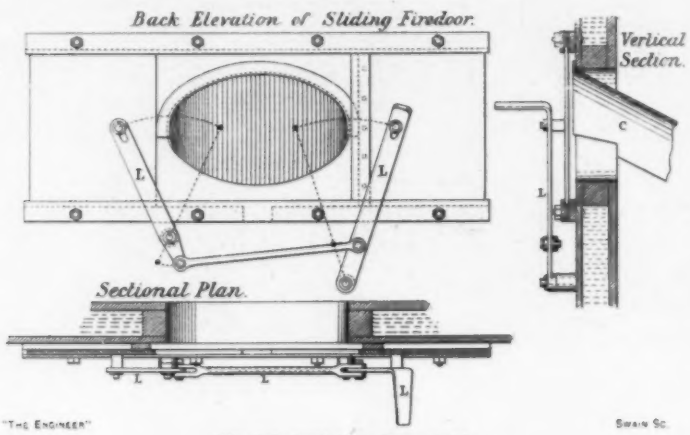


FIG. 137—MIDLAND FIRE DOOR

J. Beattie's Boiler.—The coal-burning fire-box by Joseph Beattie dated from 1853, and consisted of an auxiliary small box and grate placed outside at the back of the ordinary fire-box. Coal was burnt only in the latter and coke in the former. The main box had a transverse water bridge or diaphragm. The underlying idea was common to all Beattie's fire-boxes, in that the gases from the coal in the back box passed over incandescent fuel in the front box nearer the tube-plate, thus completing combustion.

In 1855 Beattie produced an extended and more complete modification of his system. The small outer fire-box was suppressed, and in its place the main fire-box was divided transversely by an inclined water bridge into back and front compartments, each with its separate fire-hole. The two fire-holes were in the same vertical plane, the lower one serving the back compartment. The two compartments had separate dampers. The heaviest coal firing was done in the back compartment, the gases from which passed through openings in fire tiles over the water bridge, and were then deflected downwards by the water pocket in the roof on to the incandescent fuel in the front compartment, in which only a little coal was burnt slowly. Thence the gases passed through a fire tile heat "accumulator" into a combustion chamber, which occupied half the length of the barrel, and contained a second fire tile heat accumulator. From the combustion chamber the gases passed through the tubes to the smoke-box. As these tubes were only about 5ft. to 6ft. long, a very large number, 370 to 400, only $1^3/_{16}$in. or 1¼in. diameter, were used. The combustion chamber, like the fire-box, had a flat roof and was stayed with longitudinal girders.

In 1859 the boiler had developed into the form shown in Fig. 135, which was similar in general design, but the fire tiles, which had proved a source of trouble, were discarded.

In place of the tiles in the fire-box the perforated brick arch shown was substituted, and those in the combustion chamber were replaced by a narrow vertical midfeather, which connected the water spaces above and below the chamber. The wide passage between the fire-box and combustion chamber was also replaced by a series of tubes not shown. Air was admitted through hollow stay bolts in the sides and ends of the fire-box. This was probably the most fearful and wonderful boiler and fire-box ever placed in service on a large scale, and must have caused the running shed boiler repairing staff furiously to think. But it was undoubtedly most efficient as a means of extracting heat units from the fuel, and there were no locomotives in the kingdom which could touch Beattie's in fuel economy, of which part was due to the feed-water heating apparatus. In fact, it is doubtful whether the boilers could have been kept long in service had they been fed with cold water. Nevertheless, in spite of the hot feed, the complicated combustion chamber, with its adjuncts, had to be discarded, and in Beattie's later engines, from about 1863, only the double fire-box was retained.[18] It remained standard on the London and South-Western Railway until 1877.

Cudworth's fire-box.—J. I. Cudworth, on the South-Eastern Railway in 1857, designed the double fire-box with sloping grate, 7ft. 6in. long—shown in Fig. 136. It was divided by a longitudinal water partition, and two separate fire doors, as in McConnell's system, were required. The fire-box volume was obtained without any complicated combustion chamber. Each side was fired alternately, the coal being put on underneath the doorways, where most of the gases were given off. The shaking of the engine when running caused the incandescent fuel to descend gradually along the sloping grate to the front, and the gases passing over it were properly consumed. The partition was cut away near the tube-plate, so that the gases from the two compartments could combine before entering the tubes. Cudworth's fire-box was fitted to all the S.E.R. engines, and some were in service until 1891. A large number were also used on the London, Chatham and Dover and the Brighton Railways.

Other Coal-burning Systems.—Jenkins on the Lancashire and Yorkshire Railway in 1857 used tubular stays in the front of the fire-box, and added a small hook-shaped cast iron arch in the position in which the brick arch is now placed. Yarrow on the Scottish North-Eastern Railway employed a similar arrangement with a brick arch, but the brick arch had already been fitted to a number of Midland engines. A chimney blower formed part of both systems. D. K. Clark's air induction steam jets in the sides, and later in the front and back of the fire-box, were also introduced in 1857, and after trials on the North London and Eastern Counties Railways were adopted in 1859 as standard practice on the Great North of Scotland Railway. When running the steam jets were only put into action occasionally, since the blast was then sufficient to draw a large supply of air through the tubes. The steam jets were turned on as soon as the regulator was shut. In effect, therefore, they took the place of an ordinary blower, but were more effective than the latter, since the drawn in air was distributed over the surface of the fire and effected more complete combustion of the gases.

Coal Consumption and Evaporation.—D. K. Clark ("Proc.," I.C.E., 1860) gave the following results obtained from the chief systems mentioned above, with trains of 102 to 116 tons gross weight, and average speeds, excluding stops, of 33 miles per hour :—

	Pounds coal per mile.	Pounds per ton-mile.	Water per pound of coal
McConnell	35½	.31	5.9
Beattie, with feed water heater shut off	24	.235	8.31
Cudworth	26	.225	8.6

Midland Railway Coal-burning Engines.—It was on the Midland Railway, between 1856 and 1860, that the final solution of the bituminous coal-burning fire-box problem was attained. The experiments covered a long period and were carried out by Charles Markham under Matthew Kirtley's direction. Various expedients were tried, including air tubes in the fire-box front and sides. Then brick arches of various shapes were added, and finally firehole door deflector plates of various lengths and inclinations. Some experiments included the use of a form of combustion chamber built up of fire bricks inside the fire-box. Eventually all ideas involving air holes and combustion chamber were discarded, and the tests concentrated upon the best combinations of simple brick arch and deflector plate. With regard to the latter Markham observed "that every addition made to the length of the deflecting plate attached to the fire-door was attended with marked improvement in the combustion of smoke, the plate causing the air to be deflected on to the surface of the fire." Transverse fire-box midfeathers were found to be troublesome owing to the difficulty of cleaning and removing clinker from the front part of the fire-box. Deflecting plates attached to the fire-door were found to be less convenient than loose scoops, which were substituted for them. The fire-holes were enlarged to an oval form, 18in. wide by 11in. high, and the doors made of the well-known double-sliding pattern actuated by levers, one of the simplest and most convenient doors ever designed—Fig. 137. They have the advantage that when running with the doors very slightly open the air enters at the middle only and is deflected down into the centre of the fire-box.

By the end of 1859 the Midland had arrived at the simple fire-box, with brick arch and deflecting plate as we know it to-day. The final form of brick arch—Fig. 138—consisted of nine blocks, seven 20in. long by 5in. thick, and two special side bricks with recesses to allow them to be supported by square bars, which were hidden in the recesses and therefore not exposed to the fire. Full particulars of the experiments were given in a paper by Charles Markham, "Proc.," Inst. Mech. Engineers, 1860.

It appears to the writer that one of the main reasons why the Midland locomotive department succeeded in adapting the ordinary plain coke-burning fire-box for coal-burning, whereas McConnell, Beattie, and others found it necessary to adopt combustion chambers, midfeathers and other complications, was that the Midland engineers made most of their experiments with goods engines, of which the original coke-burning boilers were of large size, with greater heating surface and larger fire-box volume than was then usual. They had 1131 square feet of heating surface, of which the fire-box supplied 84 square feet. The volume of the latter was about 69¼ cubic feet, and the grate area 14.5 square feet. The tubes, 2in. diameter, were 11ft. 9¼in. long, with ample space between them.[19] Except that the grate area

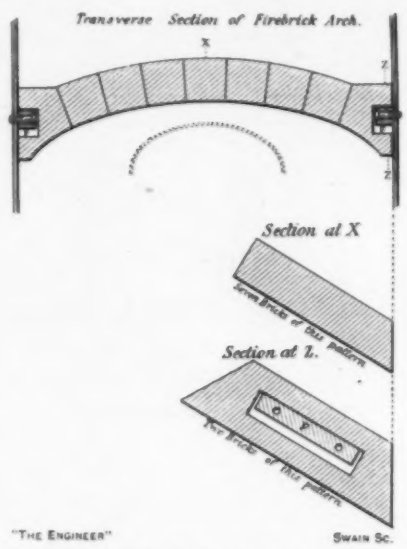


FIG. 138—MIDLAND BRICK ARCH, 1859

was somewhat small owing to the partition, the Midland boilers of 1852–9 otherwise approximated in dimensions to those built for most other railways during 1865–1874, when coal burning had become general. In 1852–3, when Beattie and others began their experiments, the ordinary coke-burning fire-boxes of the engines at their disposal were of considerably smaller dimensions, and the subsequent complicated designs resulted from efforts to obtain sufficient space and length of run for complete combustion of the gases.

The far-reaching results of the Midland experiments were not fully appreciated for some time. D. K. Clark[20] pointed out that in the Midland trials Derbyshire hard coals evaporated only 6.7 lb. of water per pound of coal, whilst Durham coke evaporated 7.9 lb. of water per pound of coke, or 18 per cent. more water. The cases can hardly be compared, if only for the reason that the goods engines, in which coke was tried in the experiments, were of very different dimensions from those using coal, though this fact was not mentioned in Markham's paper. The only fair comparison which can be made lay in the results given by two exactly similar passenger engines, No. 131, fitted with brick arch and deflector plate for coal burning, and No. 135 burning coke. These engines gave the following results :—

Engine.	Fuel.	Pounds fuel per mile, average.	Pounds water per pound fuel, average.
131	Shireoaks coal	21.38	7.0
131	Rhondda Valley coal	18.9	7.75
135	Durham coke	23.5	7.7

The coal was reported as producing clinker which affected the production of steam. When the relative

[18] See drawing of Beattie's 2–4–0 tank engine, THE ENGINEER, February 5th, 1892.

[19] Markham gave only the total heating surfaces in his paper, but the numbers of the engines were given, from which the writer has been enabled to add the above dimensions.

[20] Colburn's "Locomotive Engineering." Supplementary Chapter on "Coal Burning," page 299.

costs of coal and coke are taken into consideration, there can be no doubt as to the value of the Midland results.

Welsh Coal Burning in Locomotives.—The problem of burning Welsh steam coal of the comparatively smokeless variety differed from that which faced engineers who were testing bituminous coal. Its solution was undertaken by Joseph Tomlinson on the Taff Vale Railway in 1858.[1] Tomlinson had previously been one of Matthew Kirtley's assistants on the Midland, and was probably fully conversant with the trials then being made on the latter railway. The Welsh coal contained about 90½ per cent. of carbon and was in this respect nearly equivalent to coke. The absence of smoke rendered complicated fire-boxes and combustion chambers unnecessary, and neither brick arch nor deflector plates were required. Not even a steam jet or blower had to be used when the engine was standing. The difficulties arose owing to the intense heat of combustion on the grate. The wrought iron fire-bars burnt out, and would not last two days without having to be sent to the smiths' shop to be straightened, and some engines had to have two new sets per day to run 100 miles. With heavy firing the bars fused. Eventually, good results were obtained by covering the fire-bars with a layer of broken fire-bricks in small pieces, after which they lasted about four months. The spaces between the bars, which had been 1in. in coke-burning fire-boxes, were reduced to ⅝in., and the fire-door was made with five or six 2in. holes to admit a little air above the fire.

The fuel consumption was found to be slightly in favour of coal, as compared with coke. The water evaporated was from 7½ lb. to 8 lb. per pound of coal and was practically the same as with coke. These results were obtained on slow-speed coal trains, at speeds of 11½ to 16½ miles per hour, but when the speed was 50 per cent. higher the increased fuel consumption resulted in a 10 per cent. decrease in the water evaporated per pound of coal. The cost of coke at that time was 12s. 6d. and of coal 6s. 8d. per ton.

In addition to the economy in cost of fuel from the substitution of coal for coke, there was a considerable saving in the upkeep of fire-boxes and tubes. On an average throughout the kingdom, a set of brass tubes would last 150,000 miles, as against 100,000 miles when coke was used, and the fire-box abrasion, which was very severe, especially under the fire-door and in the lower portions of the box, when coke was used, was reduced in an even greater proportion.

A High Voltage Testing Laboratory.

MODERN electrical practice has made it necessary for the large electrical manufacturers to establish special departments for testing materials, &c., which are subjected to high voltages. No longer is it possible in these days to carry out all the tests and investigations necessary in workshops. The high voltage equipment which the manufacturers are now called upon to design, demands special testing apparatus, which must be placed in a department apart from the factory. Moreover, it is now realised by all the large electrical manufacturing concerns that research work must not be neglected, especially as a great deal is being done in this connection by competing American and continental firms.

A special testing and research department was organised some time ago by the Metropolitan-Vickers Electrical Company. One section of this department was devoted to problems relating to insulating materials and dielectric phenomena, and a laboratory was equipped with a 100,000-volt transformer. But although much valuable work was carried out in this laboratory, it was soon found that the maximum pressure obtainable from the transformer was inadequate for present-day work, and designs were therefore prepared for a new high-tension laboratory for large capacity high-pressure transformers. This laboratory, which is now in service, and which is shown in Fig. 1 and in Figs. 3 and 4 on page 482—contains a 500,000-volt transformer, and also the lower pressure equipment which was installed in the original laboratory. The company is consequently now in a position to undertake investigation on insulating materials, &c., at low and high pressures up to half a million volts. The building in which the apparatus is installed has a floor area of approximately 3264 square feet and it is 60ft. high.

There are four main sections—the control house, the 500,000-volt area, the 100,000-volt area, and the general equipment section. The control house is a wooden structure which is raised about 4ft. above the floor level of the laboratory. At the entrance there is a vestibule, and on the first floor a control room and observation gallery, whilst on the second floor there is an office. An earthed Faraday cage protects the whole of the control house, the control room itself being enclosed in glass. The testing areas can be reached from the control house by two sliding doors, which are fitted with interlocks, so that in the event of the doors being opened whilst a test is in progress, a circuit breaker on the low-tension side of the particular transformer in use is opened. In the control room there are two movable testing tables with push-button remote control gear, and crest voltmeters for the measurement of the pressures of the 100-kilovolt and 500-kilovolt transformers. There are also switches for controlling the lights in the building and for operating motors, which raise and lower the blinds. At the back of the control room is a special plug and socket distribution board for giving current supplies of different kinds. From the observation gallery the engineers can gain a clear view of the whole of the testing area, communication with the control room being obtained by means of a push-button device operating visual signals in the room below.

[1] "Proc.," Inst. Mech. E. Paper by Joseph Tomlinson, 1858, on "Burning of Welsh Coal in Locomotives."

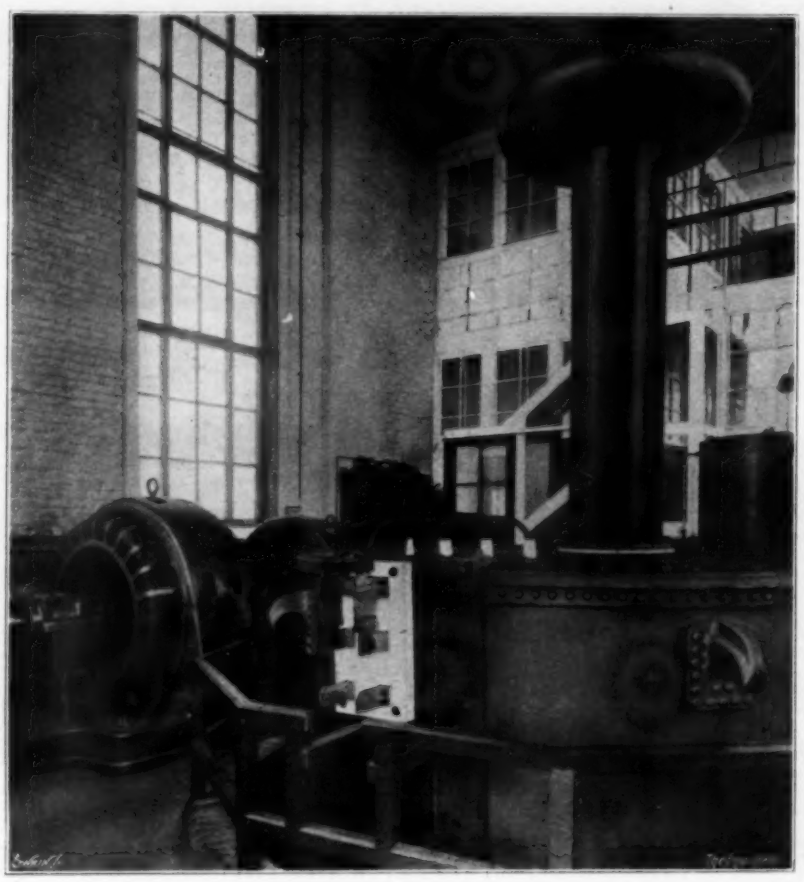


FIG. 1—500,000 VOLT TRANSFORMER AND VARIABLE SPEED MOTOR GENERATOR SETS

The 500,000/1000-volt oil-immersed self-cooled core type transformer in the high pressure section of the laboratory is rated at 500 kilovolt-ampères, and it is said to be the largest transformer designed for 500,000 volts or over in Europe. The low-tension winding, which is in two parts, is directly coupled to one phase of a three-phase eight-pole alternator through a series-parallel switch, which increases the stable range of the transformer, so that it is possible to work at the top of the alternator saturation curve with a maximum testing pressure of 500 or 250 kilovolts. The alternator, which was specially designed by the firm's power plant department for the work, has a distributed field winding so as to make the wave form approximate as closely as possible to a true sine wave. It is directly coupled to a 360 horse-power, 375–900 revolution per minute direct-current motor, and its field is excited by a 32-volt exciter, which is mounted on the alternator's shaft. On account of the large speed variation that can be obtained on the direct-current motor, it is possible to carry out tests at periodicities between 25 and 60 cycles. The high voltage is controlled by means of a motor-operated rheostat in the field circuit, which has a visual dial in the control room for showing the position of the rheostat when a test is being carried out in darkness.

The 100,000-volt testing equipment consists of a 30 kilovolt-ampère, 100,000-volt transformer, together with its motor generator set, a 20 kilovolt-ampère, 22,000-volt transformer, and a 2 kilovolt-ampère, 2000-volt transformer. The 100,000/440-volt self-cooled oil-immersed core type transformer is directly coupled to the four-pole alternator of a 15½ horse-power, 10 kilovolt-ampère motor generator set, the alternator exciting current being taken from the 250-volt mains, and it is controlled by a motor operated rheostat. A stable speed range of 1250 to 1800 revolutions per minute can be obtained, thus giving a frequency variation of 40 to 60 cycles. The 22,000 and the 2000-volt transformers are fed from a motor generator set similar to the machine used for the 100,000-volt transformer, and the low-tension windings are in two parts, which can be connected in series or parallel, so that adequate voltage control may be obtained.

The 500-kilovolt bus-bar, which extends across one end and along the length of the building, is an L-shaped aluminium tube 4in. in diameter, having spheres at each end and at the joint. It is supported from the roof by three strings of 17 suspension-type porcelain insulators in such a way that there is a minimum clearance of 15ft. all round the bar, which is provided with light leads, that can be brought down to any apparatus undergoing test.

The 500-kilovolt section of the laboratory contains a large oil tank—see Fig. 3—18ft. in diameter and having a capacity of 7000 gallons, which is fitted with electric heaters so that tests may be carried out at any desired temperature up to 100 deg. Cent. It is also provided with a movable bridge to enable investigators to get within easy reach of any apparatus that is being tested under oil. A narrow observation gallery is suspended just below the roof and it extends all round the laboratory, so that corona effects, &c., can be safely observed from above. There is also a small electrically heated oil tank for carrying out tests under oil in the 100-kilovolt area.

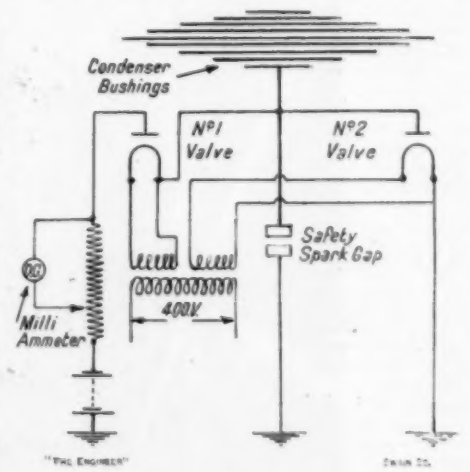


FIG. 2

Besides the equipment mentioned, the laboratory contains a number of conditioning ovens, a Vickers centrifugal oil purifying plant, spark gaps, and other apparatus necessary for the testing and research work that is undertaken. During the daytime the whole of the laboratory can be put into total darkness by means of the electrically operated blinds previously mentioned. The method of voltage measurement adopted is based on the fact that in an alternating-current circuit the average charging current of a condenser is proportional to the maximum impressed

HIGH-VOLTAGE TESTING AND RESEARCH LABORATORY AT TRAFFORD PARK

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, WESTMINSTER, ENGINEERS

(*For description see page* 481)

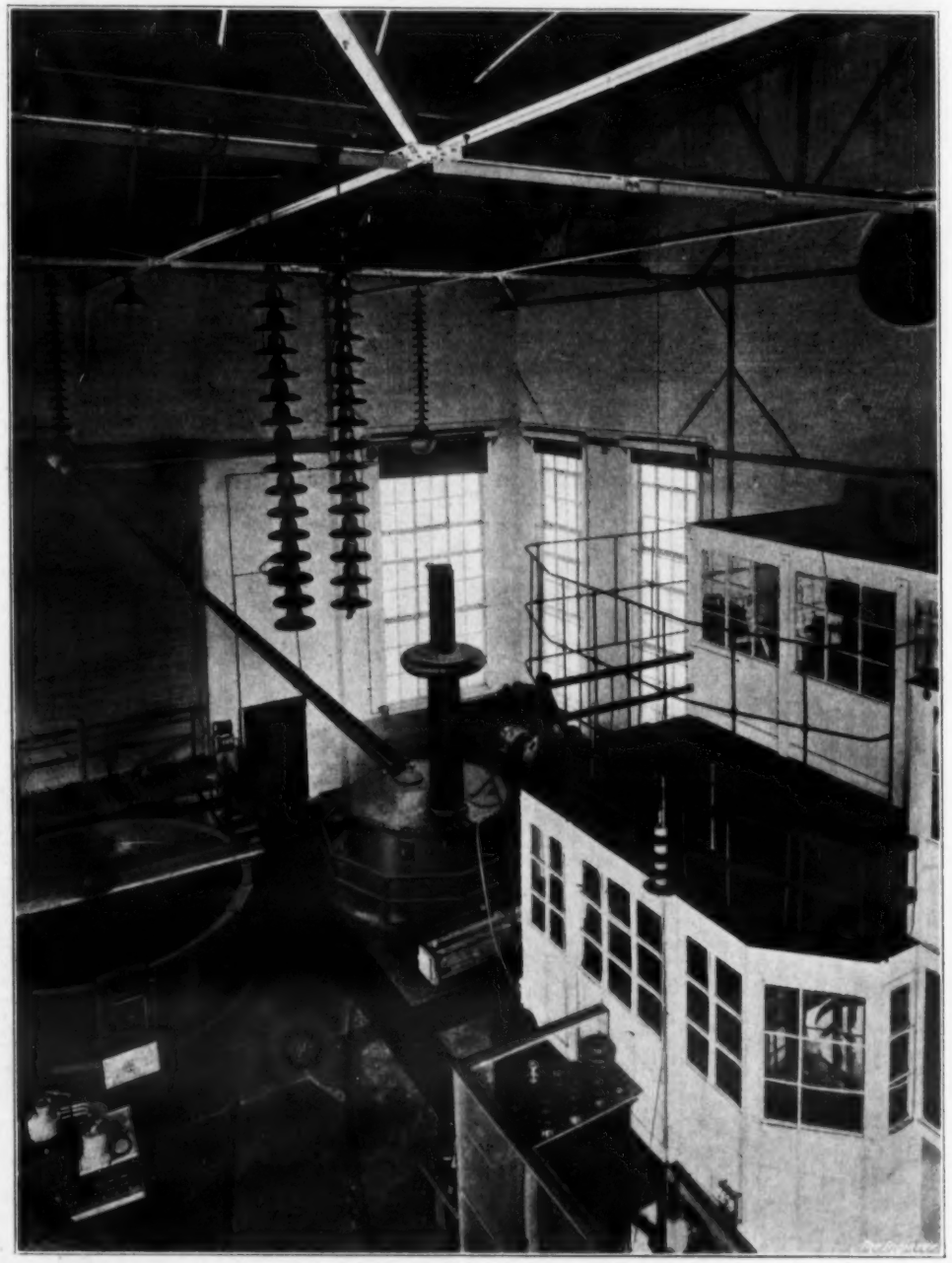


FIG. 3—GENERAL VIEW OF THE LABORATORY

FIG. 4—500,000 VOLT FLASH-OVER

voltage, and it follows that if the charging current of a condenser bushing, such as a transformer terminal, can be measured, a reading directly proportional to the peak voltage of the transformer can be obtained. The principle involved will be understood from Fig. 2. Instead of being earthed the outer banding of the condenser bushing is connected to the filament of one rectifying valve and to the plate of another valve, which also acts as a rectifier, the two valves being mounted on the valve panel in the control room. The anode of the first valve is connected to a shunted direct-current instrument and then through a 12-volt accumulator to earth.

One terminal of the filament of the second valve is connected to earth and there is a variable safety spark gap between the outer banding of the bushing and earth, and it is adjusted so that its breakdown voltage is a little greater than the voltage across the valves. The filament heating current is supplied by a small transformer wound with two secondaries, which are necessary because the two filaments are at different potentials. The reading on the instrument obtained with these connections is the average value of one half wave of the charging current of the condenser bushing, which, as already stated, is proportional to the peak voltages. The accumulator is employed in order to balance the space current of the valves. The crest voltmeter is calibrated over the entire range of the transformer against a spark gap, values of breakdown voltage for varying lengths of gap having, of course, been established under different atmospheric conditions. The calibration has been carried out for various frequencies in each case over the whole voltage range, so that the error due to the variation in the capacity of the condenser with different voltages is eliminated. The direct-current instrument is arranged to give a direct scale reading in kilovolts at 50 cycles, the corresponding values for other frequencies being obtained by a simple calculation.

The spark gaps used in connection with the voltage measuring apparatus consist of a small hand-operated gap with a horizontal sphere setting, which is also used for the 100,000-volt set, the spheres being 125 mm. in diameter. There is also a large motor-driven gap with a vertical setting for use with the 500,000-volt testing equipment, with spheres 500 mm. in diameter and made of cast duralumin, which, although heavier than the usual spun type of sphere, ensures smoother finish and greater freedom from mechanical damage. They are mounted on steel shanks, the upper one being rigidly suspended from a wooden cross-piece supported on two bitumen-filled porcelain tubes. The bottom sphere is fixed on a vertical shank, which can be raised or lowered by means of an electric motor operated from the control room. A special feature of this spark gap is a magnetic clutch between the lower shank and the driving motor, which is connected in parallel with the overload coil on the low-tension circuit breaker of the transformer. The spheres are first set a long way apart and the motor drive is switched on so that the lower sphere is gradually raised until a spark occurs, thus causing the operation of the circuit breaker overload coil and the release of the magnetic clutch. The distance between the spheres can then be measured to within 1 mil by means of a scale on the lower shank.

For carrying out artificial rain tests both inside and outside the building, extensive equipment has been provided, and in order that the actual working conditions may be faithfully reproduced the water is supplied from a large tank in which, by the addition of suitable chemicals, water corresponding to different classes of rain can be obtained. The insulators are sprayed with the water by means of nozzles, which can be set at any angle and to give "rain" varying from a very fine mist to heavy drops, the pressure necessary for rainfall of any definite amount being regulated by the addition of compressed air at the top of the water tank, which holds sufficient water for two hours' continuous testing. When it is necessary to observe luminous effects during rain tests, the experiments are carried out in the 500-kilovolt area in a small square space on a floor isolated by a drained trench which carries away the water. The majority of rain tests, however, are undertaken in an outdoor enclosure outside the north end of the building, the large shutter of which being raised so that a lead can be brought from the high-tension bus-bar to the apparatus to be tested.

It will be gathered that the Metropolitan-Vickers Electrical Company has equipped itself with one of the finest testing installations for all classes of high-voltage research. The high-tension sets in the company's transformer and switchgear departments are still used for routine testing, the essential purpose of the new laboratory being investigation.

THREE out of the four railway servants who were riding in the van of a London and North-Eastern goods train on the 16th ult. were killed. When ascending a steep gradient on the Doncaster avoiding line a coupling broke and 30 wagons and the brake ran back and collided with a following goods train. This line is probably used only for goods traffic; were it otherwise there would presumably have been runaway catch points which would have intercepted the detached vehicles.

Institution of Mechanical Engineers.

AT the meeting of the Institution of Mechanical Engineers, held in London on Friday evening last, Mr. W. H. Patchell welcomed the new president, Sir Vincent Raven, on his return from Australia and New Zealand. Sir Vincent, in acknowledging the welcome, referred to the forthcoming Railway Centenary Celebrations, and the part to be played by the Institution in connection with that important event. Two papers dealing with "Hardness Tests Research," were then presented for discussion by Mr. G. A. Hankins, of the National Physical Laboratory, Teddington, and Mr. G. A. Shires, of the University of Birmingham. Mr. Hankins' paper was a report on the effects of adhesion between the indenting tool and the material in ball and cone indentation hardness tests; and Mr. Shires dealt with some practical aspects of the scratch test for hardness.

ADHESION BETWEEN TOOL AND MATERIAL IN HARDNESS TESTS.

After describing certain miscellaneous tests, the results of which were held to demonstrate the existence of a friction-like adhesion between the indenting tool and the material, Mr. Hankins proceeded to analyse the effect of this adhesion on the figures obtained in hardness tests of the Brinell ball or Ludwig cone type. In either test the hardness number is commonly taken as being given by the applied load divided by the surface area of the indentation. As thus defined the number is known to vary for any one material in the same condition with variations in the diameter of the ball or the angle of the cone and in the applied load. It is therefore necessary to specify standard values for these variables. Mr. Hankins' investigations show that, making allowance for the adhesion factor, corrected hardness figures can be obtained which are substantially independent of the load used and the diameter or angle of the tool, and which, moreover, give approximately equal values for the ball and the cone hardnesses. The vertical angle of the cone or the ratio of the ball diameter to the impression diameter must not, however, exceed a certain limit, which is dependent upon the material being tested. It would appear that for most engineering materials within the Brinell range of 70 to 300, the standard Brinell test gives conditions lying just within the limits required. In addition, the standard Brinell test is found to give values in close agreement with the author's corrected figures. This result is explained by the fact that Mr. Hankins' correction is applied to the hardness figure deduced from the *projected* area of the impression. The use of the *spherical* area in the standard Brinell test would therefore appear to introduce a factor of the same nature and order as the author's adhesion correction. The general conclusion arrived at is that the results show no reason why, for most materials, any change should be made in the standard Brinell workshop test. They are, however, held to show that there exists a rational static indentation hardness scale in terms of intensity of pressure.

SCRATCH HARDNESS TESTS.

In the earlier portion of his paper Mr. Shires described the construction and use of what he called a practical form of sclerometer, a diamond scratching tool moved by hand over the work to be examined for hardness. This tool consists of a tubular case carrying three steel balls at one end and containing a tubular piston provided at its lower end with a pin, to which the diamond is attached. The piston is free to slide vertically within the case, but is prevented from rotating therein, and can be loaded to any desired extent by means of lead weights inserted within it. The assembled instrument is placed on the work, the balls serving as points of support, and is drawn slowly over it by hand. The width of the resultant scratch in conjunction with the load on the diamond is taken as a measure of the hardness of the material. The author explained that the use of the instrument was limited by the sensitivity obtainable in the microscope employed for measuring the width of the scratch. Using a microscope with a micrometer eyepiece he found it possible to estimate scratch widths to 0.0005 mm. With such a limitation in the measuring equipment it is not possible to apply the scratch method with accuracy to materials of Brinell hardness beyond about 300. Further difficulty arises from the fact that the correlation of the scratch hardness number with the Brinell figure demands a lengthy calibration for each diamond separately. The author prefers to employ Hankins' expression for the scratch hardness figure as a definite measure without reference to the Brinell number. The paper concluded with a discussion of the advantages of the scratch test over the Brinell test. Among such advantages special attention was drawn to the fact that the scratch test provides a quick and ready means of examining any continuous variation of hardness over a considerable area on the surface of a specimen.

The discussion was opened by Dr. W. C. Unwin, who paid a tribute to the high standard of the papers which were read by the members of the staff of the National Physical Laboratory. Mr. Hankins' paper was, he thought, most valuable, because of the new ideas expressed in it which cleared up a number of existing doubts and difficulties. Indentation hardness might be expressed as the load on the tool divided by the area of indentation. It was shown by Mr. Hankins, however, that a part of the load was supported by adhesion or friction, and the expression should therefore be:—Load minus friction over the area of indentation. In the Brinell test the load was divided by the spherical area, whilst the conical area was employed in the Ludwig test, but the speaker thought that the projected area should be taken, which in the case of the ball test would be πr^2 and not the more complicated expression for the spherical area. If that were done, he thought that the hardness figures obtained from ball tests would closely agree with those of the cone test. At the time the suggestion was made some experiments carried out by Mr. Batson seemed to throw doubt on the method proposed, but Mr. Hankins had included in his paper some of Mr. Batson's results, to which the adhesion or friction correction had been applied and in which the projected area was used. Those results gave agreement between the ball and cone tests. In the summary of the results given by Mr. Hankins, it was shown that, for a given indentation tool, the hardness was approximately constant over a considerable range of loading, and that the ball tests agreed with the cone tests. It was certain that Mr. Hankins' new values were truer than the numbers as ordinarily calculated. With regard to the lubrication of the tool, it was shown that lubrication increased the size of the indentation, which, with reduced friction, was to be expected. In the ball type of test lubricating the ball made but little difference. Dr. Unwin held the view that the lubricant was squeezed out, and that, as it was very difficult to clean the whole surface of the ball, the surface, in practice, was always slightly lubricated. There was a danger, he thought, of the assumption in Meyer's law that the load was proportional to the square of the diameter of the ball, becoming a fetish. Mr. Hankins showed that the load must exceed a certain minimum limit, and that if the pressure of fluidity was not reached the full hardness of the material was not brought out. Consistent hardness results were also obtained over a considerable range of load. Some years ago he (the speaker) advocated the cone test, on account of the hardness number obtained being constant over a greater range of load than was the case with the ball test. Further advantages of the method were the ease with which the coefficient of friction might be determined, the simpler working formula, and the ease of application of the test, which made possible the use of a black diamond or an artificial sapphire. He thought that it might be possible to test very hard materials in that way. There were, of course, exceptional materials, of which manganese steel was one. In view of the viscous character of that metal, it was probable that it was necessary to apply the load not for seconds, but for twenty-four hours before the limit was reached. Other materials also behaved exceptionally, and it would be necessary to take them into consideration when extending the scope of the test. Engineers were still in want of a hardness test for materials with a Brinell number above 500, beyond which point the Brinell test was admittedly not quite satisfactory.

Professor B. P. Haigh said that one beauty of the Brinell test was that it focussed attention solely on the diameter of the indentation. Research had shown, however, that it was of great advantage to look at the metal surrounding the indentation. There was a striking difference between the crater formation in the cases of hard drawn and annealed copper. With the hard drawn material, there was a shorter and sharper slope from the raised edge of the indentation to the surface of the metal, and a smaller zone of deformed material beneath, while annealed metal showed a longer and more concave slope with a larger deformed zone. (This point was well illustrated by lantern slides, which showed sections of the different materials after a prism test.) It was obvious that the stresses set up were different. If the strength of a material were defined as the resistance offered by it to a simple stress, then hardness might be said to be the resistance offered by a material to complex stresses. There was no reason why deformation caused by friction should not be taken into account in computing hardness, and he did not think that we should accept the idea that friction should be eliminated or that we were justified in eliminating it. In experiments he had carried out with a view to regularising friction, he had found only ½ per cent. alteration in hardness. With plain yellow soap used as a lubricant, that difference was increased to 5 per cent. In the prism test there was less slipping, and friction, apparently, had no effect when yellow soap was used as a lubricant.

Dr. W. Rosenhain discussed the effect of lubrication in the indentation test. If time were allowed, he said, the lubricant would escape, and he thought that the rate of indentation was an important factor. The friction was a function not only of the lubricant, but of the contact surfaces themselves, and depended on the finish of the tool. Mr. Hankins had used a finely finished cone, but in a recent paper Mr. Hultgren had described experiments in which a tool roughened by etching was employed. The frictional effect due to roughing was not important if the depth of the impression were slight. A matt surface had been shown to be justified, but he did not know whether it

could be applied in the cone test. It was interesting to note that cones of different angles gave almost identical contact pressures when the adhesion correction was applied. There should, however, be a difference in the cold working effect between, say, a 120 deg. and a 30 deg. cone. He agreed with Dr. Unwin that the flow pressure of the metal must be exceeded, and Professor Haigh had also shown that the deformation of a large zone of metal depended on the previous hard working of the material. It was surprising that no difference had been found, and further experiments were required. In the case of manganese steel, cold working effects were very marked, and he would not expect to find the contact pressures constant. Referring to Mr. Shires's paper, he noted that the scratch test had broken down on very hard materials, and that experiments on glass had been given up owing to the damage done to the diamond. Much could be learned from the methods of the setters who prepared diamonds for glass cutting. There was a great difference between cutting and scratching glass, and scratching occurred when the diamond chattered. In cutting and scratching, very hard steel was analagous to glass, and it would be worth while to use heavier loads giving deeper scratches, but the diamond would have to be set at the correct angle. If cleavage angles were used, there was a possibility of reproducing cuts of uniform depth and width, but care must be taken in developing this method to investigate the origin of apparent discrepancies. With regard to the scratching of sprayed metal, such a metal might be likened to a series of hard particles cemented together with putty. A gentle application of the diamond would give a fine scratch but a deep cut would tear up the embedded particles. Scratch hardness was a measure of surface hardness, but a measure of strength entered into the indentation method.

Dr. Harold Moore commented on the fact that lubrication was not generally used in making Brinell tests. He did not doubt the existence of an adhesion or friction effect, and such an effect was known in compression tests. When compressing small cylinders of annealed copper between hard and polished faces, so that friction was eliminated, there was none of that barrelling of the specimen which occurred when friction between the plates and the test piece was present. He questioned the magnitude of the adhesion effect in ball testing, which was exaggerated by the method of calculation employed. Taking a 45 deg. cone and comparing it with a 90 deg. cone, and considering its cold working effect, it seemed unlikely that the same contact pressure would be obtained by applying a correction for adhesion only.

Mr. P. V. Vernon spoke from the point of view of the man in the shops. He had expected an onslaught on the Brinell test, but he felt that the position of that test was strengthened by the papers. It was applied easily, quickly, and involved no complicated measurements. He was not convinced that there was friction at the surface of the ball, so much as internal friction among the particles of the test piece themselves. That point was worth examination. In a letter to THE ENGINEER, published on October 20th, 1922, he outlined tests in which sectioned and etched specimens were examined, showing the hardening action of the ball and the deformation lines produced. More work on those lines would give valuable results. Mr. Hankins had employed a single lever Buckton machine in making his tests, but with such a machine it was difficult to get uniform results on the same material owing to the inertia of the beam, and uniform times were also difficult to obtain. In making tests the time during which the load was applied was more important than the time during which it was maintained on the specimen. It was better to slow down the application and reduce the duration.

Mr. P. W. Cooper, also speaking as a practical man, dealt chiefly with Mr. Shires's paper. That paper, he said, clearly emphasised the value of the scratch test for hardened materials. In the business with which he was connected uniformity of hardness was of paramount importance, and after testing other methods and passing from the Brinell to the Rockwell test for small sections, the scratch test had been finally adopted as being finer and more trustworthy. There were certain discrepancies between the results obtained by the scratch or filing test and those given by the Brinell and Rockwell methods. He doubted whether the indentation test was useful for hardened materials. Specimens which had the same analysis and and showed the same Brinell number often exhibited marked differences in machining. Engineers required a hardness testing machine which would not deform the surface of a material, for such a deformation often meant rejection.

Mr. R. S. C. Batson referred to the previous papers on hardness discussed in 1923—see THE ENGINEER of April 27th of that year. He pleaded on that occasion for a rational scale of hardness, and Mr. Hankins had now evolved a method of bringing the ball and cone tests into line. He felt, however, that the adhesion theory was not the last word, and that there were other factors to be taken into account. The Brinell test, in spite of some pitfalls, would remain, and from the empirical scale it might be possible to reach the rational scale. Mr. Shires's paper put the scratch test in a rather poor light, for it showed that it was not suited for workshop use, and that it called for skilled observation and measurement. The bibliography given by Mr. Shires was useful, but much work was done before 1850.

Mr. H. S. Rothwell expressed a somewhat different view to other speakers, and said that Mr. Hankins had treated the indentation test rather from the point of view of a wedge splitting a block of wood, whereas in reality the process was rather more akin to a ball falling into a dense liquid. He recalled experiments in which the splash of a steel ball dropping into mercury had been photographically recorded. The surface friction, as indicated by Mr. Hankins, did not seem to tally in different cases.

A vote of thanks to the authors was proposed by the President, to which the authors replied. Mr. Hankins stated in reply to Mr. Vernon, that the results obtained with the Buckton machine were perfectly satisfactory. They were honoured with the presence of Dr. Unwin, and they hoped that the work done would be of service to the industry.

Vibration in Engine Test Gear.

By J. MORRIS, B.A.

CONSIDERABLE vibration is frequently set up when engines are tested with dynamometer gear. Such vibration is sometimes so intense that parts shake loose and the conditions of the test shop are rendered extremely uncomfortable. Even if the vibration is not excessive carburation in the case of an internal combustion engine may be upset owing to the shaking of the carburetter, thus making a proper test impossible. Many such cases have been brought to the author's notice, and as a result of his investigations he does not feel at all surprised that the trouble is so prevalent, particularly with regard to high-powered aircraft engines.

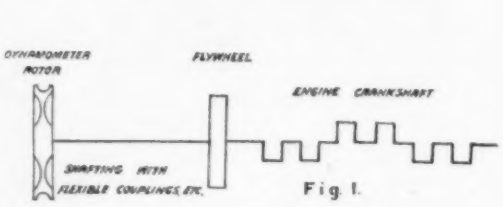


Fig. 1.

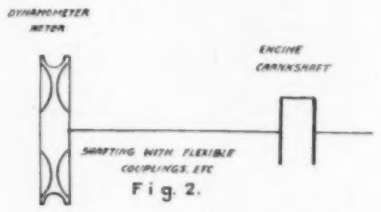


Fig. 2.

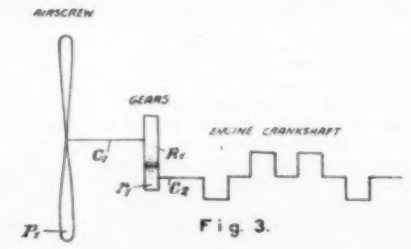


Fig. 3.

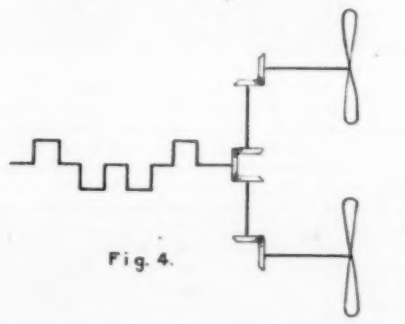


Fig. 4.

"THE ENGINEER" DRAWN BY

It seems extraordinary that whilst the utmost care is exercised in the design of an engine to avoid undesirable vibration, yet when laying out a test gear for the same engine little regard is paid to ensure that the test gear is satisfactory from the point of view of vibration. What appears to have been overlooked is the fact that, in a combination of engine, transmission shafting and dynamometer, the original system is completely changed, and, apart from power considerations, the behaviour of an engine with test gear cannot in general be expected to conform to or in any way approach that of the engine in normal circumstances. Again, the introduction of gearing may so alter the system that a perfectly satisfactory engine with a direct drive may, when adapted to take a geared drive, behave quite differently from the original in so far as vibration is concerned.

In both aircraft engine test gear and in power transmission systems practical considerations generally entail the employment of long shafts between the engine and the point at which the power is absorbed or utilised. It thus seemed to the author most probable that the troubles experienced arose mainly from torsional vibration. Of course, there are other important factors, but an inspection of the torsional stiffness of the long shafting in relation to the other data made this phenomenon apparent. The examples given are based on practical experience, although the numerical values are not those for any particular engine.

In one case which was put before the author a six-cylinder vertical engine of some 800 horse-power at 1200 revolutions per minute was provided with a heavy fly-wheel in lieu of the airscrew, and to this fly-wheel a dynamometer was coupled up, a shaft some 6ft. long and about 3½in. diameter being interposed between the dynamometer rotor and the fly-wheel, as shown diagrammatically in Fig. 1. During test very rough periods were experienced in the neighbourhood of 800 and 1200 revolutions per minute.

At first sight the calculation of the periods of torsional vibration of such a system may appear a formidable task. The problem, however, is not so difficult as it looks, for owing to the heavy fly-wheel it can be proved that the torsional periods will approximately be a combination of those on either side of the fly-wheel, the latter being regarded as a fixture.

If P is the polar moment of inertia of the dynamometer rotor and c the torsional stiffness of the shaft between the rotor and fly-wheel, the frequency of torsional vibration of the system arising mainly from the part to the left of the fly-wheel will be

$$f = \frac{1}{2\pi}\sqrt{\frac{c}{p}} \quad . \quad . \quad . \quad . \quad (1)$$

where $p = \frac{P}{g}$, P being in lb. in.², g in in./sec.², and c is in lb. wt. inch units. When the numerical values were inserted in (1) it was found that $f = 60$ double vibrations per second. Since the engine has six cylinders the frequency of the firing impulses will be $\frac{6N}{120}$, where N is the speed in revolutions per minute.

Hence when

$$\frac{6N}{120} = 60,$$

i.e., when N = 1200 revolutions per minute, there will be resonance between the torsional frequency found and the frequency of the torque due to the firing impulses. This result appears to explain the rough period experienced at 1200 revolutions per minute.

With regard to the rough period at 800 revolutions per minute, the author could not trace it to any resonance with the engine impulses. So he decided to look into the *modus operandi* of the dynamometer. In this work he was considerably assisted by Messrs. Heenan and Froude, who kindly placed some of their valuable experience at his disposal. Some years ago there occurred at about the same time two very serious cases of vibration during the testing of Diesel and gas engines with Froude dynamometers. After some consideration Messrs. Heenan and Froude arrived at the conclusion that the cause of the vibration was the use of an unsuitable number of vanes in the rotor and casing of the dynamometers. If we have, say, twelve vanes in the casing and thirteen in the rotor, every time a casing cup coincides with a rotor cup a force is exerted which is only partially balanced by the force resisting rotation on the opposite side of the axis of the shaft. If we change the number of vanes in the rotor to fourteen, coincidence of the cups takes place simultaneously on each side of the axis, causing power to be absorbed with the aid of a true couple instead of by an imperfectly balanced torque effort on one side. Again, with the 12/13 combination the frequency of the resisting torque is 156 times per revolution, and with the 12/14 set the frequency is 84 times per revolution. Thus the change from thirteen to fourteen cups in the rotor not only produced a balanced torque, but altered its frequency. On substituting the fourteen cup rotor in both cases the trouble was overcome and the machines ran as smoothly and noiselessly as could be desired. Since that time all Messrs. Heenan and Froude's dynamometers are fitted with an even number of vanes in both casing and rotor, in which special precautions have been taken to ensure balance and smooth running.

With regard to the dynamometer in the case under discussion, there were fourteen cups in the casing and sixteen in the rotor, so that the frequency of the dynamometer torque at N revolutions per minute was

$$\frac{14 \times 16 \times N}{2 \times 60} \quad . \quad . \quad . \quad . \quad (2)$$

NOTE.—If there are n_1 cups in the casing and n_2

in the rotor then it can be shown that the frequency of the resisting torque is

$$\frac{n_1 n_2}{\text{H.C.F. of } n_1 \text{ and } n_2} \text{ per revolution.}$$

Hence if we equate (2) to 1100, which was found to be the highest torsional frequency of the system, we have

$$\frac{14 \times 16 \times N}{2 \times 60} = 1100$$

or $N = 600$ revolutions per minute approximately.

Considering the various approximations which have to be made to obtain the higher frequencies of the system, it seems probable that this resonance is the cause of the rough running observed at 800 revolutions per minute.

Next take the following case. A radial engine was coupled to a dynamometer as shown in Fig. 2. The engine was found to behave perfectly satisfactorily on test, but when mounted in a machine gave serious trouble. The following investigation will readily explain the reason.

Let P_1 = the polar moment of inertia of the crank shaft system. To determine this quantity we take the moment of inertia of the throw about the centre line of the crank shaft together with the rotating load + half the reciprocating load, the latter two loads being regarded as concentrated at the crank pin. Let P_2 = the polar moment of inertia of the dynamometer rotor, c_{12} = torsional stiffness of the complete shaft between the engine throw and the dynamometer rotor.

The frequency in torsional oscillation (f) of the system is given by

$$f = \frac{1}{2\pi}\sqrt{c_{12}\left(\frac{1}{p_1} + \frac{1}{p_2}\right)}$$

where $p_1 = \frac{P_1}{g}$ and $p_2 = \frac{P_2}{g}$, g being in ins./sec.^{2}

When the numerical values were inserted it was found that $f = 90$ double vibrations per second. The engine had 9 cylinders, so that there would be synchronisation between the engine impulses and the above frequency when

$$\frac{9N}{120} = 90$$

or $N = 1200$ revolutions per minute.

Thus except at this speed the engine will be free from torsional trouble during test.

Suppose now we consider the engine fitted with an airscrew and mounted in an aircraft. If P_2 = polar moment of inertia of the airscrew and c_{12} = torsional stiffness of shaft between engine throw and airscrew it was found that $f = 150$, leading to torsional resonance when $\frac{9N}{120} = 150$ or $N = 2000$ revolutions per minute approximately. But 2000 revolutions per minute was near the top running speed, and so we see very clearly that in this case, although the engine suffered from a very severe fault, this defect could not be detected on the dynamometer. Eventually the airscrew shaft was stiffened up and the trouble overcome.

From the point of view of power output, a high number of revolutions per minute is necessary in the case of an internal combustion engine; to attain the best efficiency from the airscrew, however, its speed should not in general exceed a figure much below the maximum for the engine. Thus we have normally antagonistic requirements, namely, a high speed for the engine and a moderate speed for the airscrew; and it is important in engine design to reconcile these two opposing conditions. In the case of stationary engines this result is usually accomplished by suitable gearing. With regard to rotary engines in which the airscrew is usually rigidly attached to the crank case no attempt appears to have been made to run the airscrew at speeds differing from that of the engine itself. Designs, however, have been submitted of rotary type engines in which the crank shaft, instead of being fixed, revolves in the opposite direction to that of the engine. The need for a variable gear and means of varying the pitch of the airscrew are long outstanding requirements.

Suppose Fig. 3 represents an aircraft engine with a geared drive. P_1 indicates an airscrew of considerable moment of inertia. Let the engine be geared down in the ratio r_1/R_1 and the gear wheels be comparatively light. Then if c_1 is the torsional stiffness of the shaft between P_1 and R_1, and c_2 that between r_1 and the first throw, it can be proved that as far as torsional oscillation is concerned, the drive can be regarded as being a direct one with a shaft between P_1 and the first throw of a torsional stiffness c_{12} given by

$$\frac{1}{c_{12}} = \frac{1}{c_2} + \frac{R_1^2}{r_1^2 c_1}$$

This result is what we would get by ignoring the gears and reducing the stiffness of the shaft between P_1 and R_1 in the ratio r_1^2/R_1^2. The reverse holds good if we gear up. The effect of gearing on a propeller shaft is, therefore, virtually to diminish or increase the torsional stiffness of such shaft as the square of the gear ratio according to whether the system is geared down or up. From this result the danger of gearing down and using long flexible driving shafts is apparent. In this connection it is interesting to note that in the Zeppelin L.33, in which the engines drove airscrews through gearing and shafts some 40ft. long, these shafts were geared up at the engines, the reduction taking place at the airscrews.

With regard to the effect of gearing on torsional vibration the following case which was investigated may be of interest. In this system two airscrews were driven off one engine through the medium of shafting and gearing as shown diagrammatically in Fig. 4. The engine, normally geared down and driving a single airscrew, was found to have a torsional period in the neighbourhood of 1000 revolutions per minute. When, however, it was set up as in Fig. 4, the torsional period was found to be in the neighbourhood of 600 revolutions per minute. These values were ascertained by mathematical investigation. Subsequently a ground test was carried out and demonstrated that the greatest vibration was experienced at these speeds.

There is still a good deal to be learnt about these problems, but a start has been made. The author understands that in the most recent design of Froude dynamometer the combination of the number of vanes in the power-absorbing portions with the use of very stiff shafts has been chosen with a view to raising the frequency of torsional vibration of the dynamometer system to a value far outside the normal range of working speeds. If care is exercised in the design of the transmission, resonant torsional vibration should be entirely eliminated.

Swiss Railway Electrification.

In a paper recently read by Mr. E. A. Eborall before the North-Western Branch of the Institution of Mechanical Engineers on "Swiss Railway Electrification," descriptions were given of early electrifications, including that of the Burgdorf–Thun Railway, the experimental line between Seebach and Wettingen, and at a later date the more comprehensive electrification of the Simplon and Loetschberg lines. Factors which had an important influence on the electrification schemes of the Federal Government are the dependence of Switzerland on external sources for its coal supply, and, on the other hand, the abundance of water power. In all, some 4,000,000 horse-power of water power is available, or approximately 1 horse-power per head of the population. Of this, about 1,000,000 horse-power is at present utilised for the generation of electricity.

The three systems which came into consideration when the Federal Government decided to adopt a general policy of electrification, were the three-phase alternating current, single-phase alternating current, and direct current. After close investigation of the relative merits of each, it was finally decided that a single-phase system would be the most suitable, and it therefore became necessary to provide a separate supply system for the railway services. Water power stations of the high head type have been erected at Riton, Amsteg, and Barberine, whilst a further power station is approaching completion at Vernayaz. In addition to these, it is expected that a fifth source of supply will be realised in the future by the construction of a low head station at Rupperswill on the Aare. From the generating stations, power is distributed to a series of sub-stations along the line, which feed the overhead conductors at 15,000 volts, 16⅔ cycles.

Proceeding to the electric rolling stock employed on the Swiss Federal Railways, the author first described the 1–B B–1 type, which is at present principally used for hauling passenger trains between Lucerne and Chiasso. The locomotive weighs 108 tons, and is capable of hauling a 300-ton train at a speed of 31 miles per hour up a gradient of 1 in 28, or at 45 miles per hour on the level. The equipment comprises four 500 horse-power single-phase commutator motors, which are fed from a step-down transformer, equipped with low voltage tappings for starting, which is carried on board. For goods services, a heavier type of locomotive is employed, namely, the 1–C C–1, which is articulated and capable of developing a higher tractive effort at a lower speed. In this type regenerative braking is effected by separately exciting the field windings of the motor from a section of the transformer, and at the same time inserting a reactance coil in series with the armature. By using a suitable size of reactance, the motors, when acting as generators, oppose a constant torque to rotation from standstill up to high speed.

The author then described a form of geared drive between motors and driving axles which has been employed in the latest passenger locomotives of the Swiss Federal Railways. This drive permits the whole of the motor weight to be sprung, and enables constant engagement to be maintained between the gear wheels irrespective of axle displacement, whilst it transmits practically even torque. By the employment of this type of transmission, the difficulties inherent in the use of either side rod drive or of the so-called tramway type of motor suspension, are overcome.

Proceeding to the financial aspects of the electrification of the Swiss Federal Railways, the author stated that the Government's programme had been accelerated in order to provide employment during a period of industrial depression. As regards the cost of operating the system, a balance struck between working costs for the electrified system in 1928—when the first stage of the electrification programme will have been completed—with those of steam working, would show rather unfavourably to the former, on account of the heavy interest charges on invested capital. Having regard to the fact that the electrification was accelerated to provide relief work, the Government's contribution towards its cost had to be taken into account, and it was estimated that electric working would show a saving over steam operation, assuming that the price of coal did not decrease below 46s. per ton at the Swiss frontier. It had also to be borne in mind that on the electrified lines a much quicker and more efficient service could be maintained, and that the greater the traffic density, the more would electrical operation show to advantage in comparison with steam.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE USE OF ELECTRICITY.

SIR,—With reference to the leading article, "The Use of Electricity," in your issue of yesterday's date, I should like to point out that until cheaper electrical power can be obtained in this country, our endeavours to lessen the cost of production are largely negatived.

I am a shipbuilder engaged in building craft of small tonnage, my yard, as far as tools and lay out is concerned, is quite up to date, all the machine tools are electrically driven, each one having its separate motor, and I have done everything possible to cut costs to the lowest figure, and yet I am hopelessly out of the running in competition, as far as prices go, with the continental shipbuilders.

To endeavour to ascertain the reason of this I have recently visited a number of Belgian and Dutch shipyards, and found that not in one single instance was the equipment of any yard better than, and in many cases nothing like so good as mine, but they all had the advantage of cheap electrical power.

In Antwerp the cost of electricity was five centimes (Belgian currency) per unit, and in Holland in many cases it was the equivalent of a halfpenny per unit, and in no case did it exceed a penny, whereas I am charged by my local electric supply company 2.3 pence per unit for power purposes on a minimum consumption, which if not used increases the charge for the energy actually used to threepence or more per unit, and this at a seaport, where the coal for the generating station is waterborne.

There is no doubt that Belgian, Dutch and German shipyard labour is cheaper and working hours and conditions much more favourable than ours, and in some cases material costs are less; further continental shipyards have nothing like the handicap we have in this country in respect of overhead charges, and the advantage they have of cheap electrical power is one of their greatest assets.

Under the circumstances I have narrated, it is little wonder that "the demand for electrical plant from general industry is moribund." It will remain so to the detriment of this country until the use of it can be made far cheaper than it is to-day.

BRITISH SHIPBUILDER.

London, April 25th.

AIRSHIP DEVELOPMENT.

SIR,—The mishaps to Shenandoah and R 33 go to prove conclusively that the first step in serious development of this class of aircraft is toward safe docking and mooring facilities.

Unlike the sea-borne power-driven vessel her moments of greatest risk are when making or leaving port or when lying to anchor in bad weather and, apart from being blown out of her course, probably her greatest safety when she is drifting with all power off irrespective of any velocity of wind.

It therefore becomes of increasing interest to consider how far practices dictated by years of sea experience may be applied to craft at once so bulky and so light, *e.g.*, why should not the practice of steaming ahead to ease the strain on anchors and cables be applied to an airship moored to a mast in a gale? That such action was not taken presupposes that there must be some good reason, but, on the face of it, it is difficult to see what it is.

Especially is this conclusion forced on us by the fact that after breaking adrift the R 33 was enabled with damaged bows presenting increased resistance to a head wind to maintain herself head-to-wind for many hours, and, so we are advised, at a practically constant altitude.

We are thus faced with the deduction that either it is easier to hold an unanchored airship head-to-wind with her helm and engines than it is to run her motors ahead with her nose fast to the mooring attachment—*or*—that if this latter course had been adopted, she would not have broken away at all!

It would be invidious to infer that those responsible for the safety of the vessel are not the best judges of what should or should not be done; but the question on the face of it is of such importance, and the logic of the argument so apparent, that I venture to ventilate it, if accorded space, with a view to eliciting the opinion of readers who have handling experience with this class of vessel. Clearly the cases of the marine and airship are not quite parallel, but they have so much in common that marine trained opinion may be permitted without offence to seek enlightenment.

"NAUTICUS."

Yorkshire, April 25th.

DOLIUS AND SYCAMORE.

SIR,—There should be no difficulty, for one versed in the fundamental laws of physics, in explaining the apparent discrepancies in the tests of the Sycamore and the Dolius. It is only one more example of the conservation of energy.

Some years ago I was concerned with the operation of an electricity works at Portsmouth, New Hampshire. At one time we appeared to be losing a large quantity of power in some unexplainable manner. The quantity of current distributed from the works and used by the auxiliaries was very much less than that generated by the prime movers. Each of the watt-hour meters came to rest when its circuit was opened, showing that at one point at least, and that a very important one, its calibration curve was correct. This condition continued for several weeks. An explanation was sought in vain. Suddenly, although no change had been made in meters or wiring, the discrepancy reversed itself. More power was used or distributed than was generated. This condition continued for several weeks also, but eventually normal conditions were restored, and the metered current generated balanced with that used or distributed. A careful computation was then made of the number of kilowatt-hours lost during the earlier period, and the number of kilowatt-hours gained during the later period. It was found that the two quantities were exactly equal.

Now, if you will calculate the exact number of foot-pounds or horse-power hours which disappeared from the shaft of the Sycamore, you will find that precisely the same number of foot-pounds or horse-power hours reappeared in the shaft of the Dolius.

WILLIAM F. RYAN,
A.B., M.M.E., Mem. Am. Soc. Mech. Eng.

Syracuse, New York, April 20th.

New Single-phase Equipment for the Southern Railway.

BEFORE the grouping of the Southern Railways took place it was intended to run electric trains to Brighton, and it is well known that Sir Philip Dawson adopted the single-phase system on that account. The recent extensions which have been carried out on the original London, Brighton and South Coast Railway have necessitated the use of 21 additional motor coaches, 60 driving trailing coaches, and 20 non-driving trailer coaches, and the electrical equipment for these coaches, which embodies new features, has been built at the Witton works of the General Electric Company.

One motor coach is used for each train unit, and, apart from the control equipment on the driving trailer coaches, the control lines, lighting apparatus, &c., each motor coach contains all the electrical apparatus required, but no accommodation for passengers, for all the space available, apart from that taken up by the electrical gear, has been allotted to the guard's van. Each of these motor coaches—see Fig. 1—can be controlled from both ends and can be used for working in either direction at either end of a train, without turning round, so they may be used for hauling ordinary coaches in the same way as steam locomotives.

At present a train unit is made up of five coaches with the motor coach in the middle, the remainder of the train unit consisting of three driving trailer coaches and one ordinary trailer coach. Naturally this make up can be varied to suit traffic conditions, and during the rush periods two five-coach trains are coupled together. The additional driving position has been provided for securing flexibility in the formation of the trains. With the exception of the air compressor, the equipment of a motor coach is duplicated at each end of the coach, an arrangement which is very advantageous in the event of a fault in one section, as the coach can then still be operated by the remaining gear.

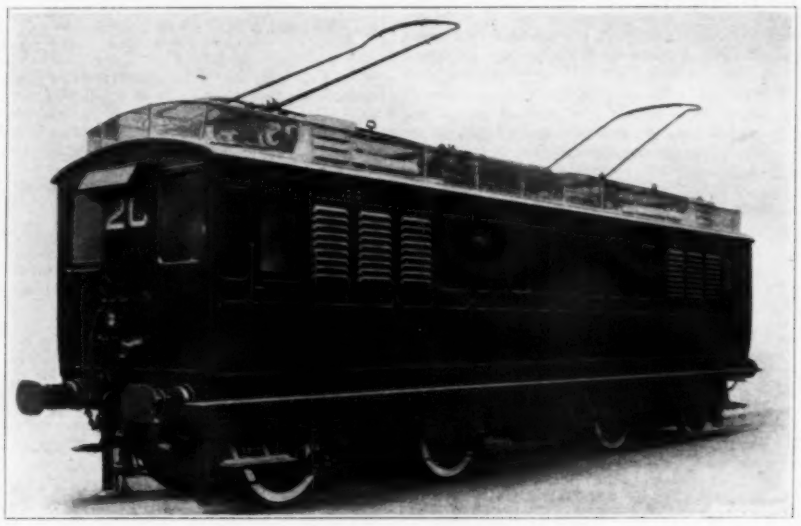


FIG. 1—MOTOR COACH

The equipment belonging to each section consists essentially of a bow collector, main and auxiliary transformers, two motors, and the necessary switch and control gear, which is of the "all electric" type. There is a duplex type bow collector for each section, and the coaches can be run in either direction by raising the appropriate bows, which are controlled through a valve by the reversing contactors, which are operated from the master controller. In the design of the bows great care was taken to ensure sparkless collection, and the springs which maintain the pressure on the bow are entirely insulated from the current carrying parts, with the result that, in the event of breakage, a short-circuit cannot occur on the roof of the coaches.

From the collector gear the current passes to the main oil switch *via* choke coils and two high-tension fuses. The oil switch is fitted with interlocks and overload releases which are in the form of a separate relay. The main transformer—see Fig. 2—auxiliary transformer and preventative coil, are all contained in an oil tank, which is cooled by a forced draught blower unit—shown in Fig. 3—but in practice it has been found that the blower only has to be used to a very limited extent. The main transformer has five tappings and, together with the preventative coil, gives seven running voltages, which give very smooth acceleration. For supplying the various auxiliaries, such as the blower motors, compressors, control gear and lighting, the auxiliary transformer is also provided with suitable tappings. Four interlocked contactors serve for reversing purposes, whilst acceleration is obtained by a set of seven contactors, which are also fitted with interlocks to make them close in the proper sequence. All the contactors, which are duplicated for each section, are of similar type, and are operated by single-phase solenoids.

The motors are single-phase series-wound compensated machines with interpoles, and are self-ventilated, although external forced ventilation is also provided by the motor-driven blower—shown in Fig. 3. With external forced ventilation the rating of the motors is 200 brake horse-power at a train speed not exceeding 34.7 miles per hour. On the one-hour basis, however, 225 brake horse-power can be obtained without external forced ventilation, at a speed not exceeding 32 miles per hour, and 250 brake horse-power with external forced ventilation at a maximum speed of 30.5 miles per hour. Higher speeds than those specified were, however, obtained on test. The ventilation is carried out on the double parallel flow system, and the motors are designed so as to exclude the entrance of dust, oil and moisture.

FIG. 5—METHOD OF REMOVING TRANSFORMER

Although the main case is designed so that the stator core fits into it tightly, the core is self-contained, and when necessary it can be pressed out of the case as an independent unit. For lubricating the bearings, in accordance with the waste method large reservoirs are provided, so that the motors can run for long periods without attention. The brush holders are of the "pistonic" type, as developed by the consulting engineer. The bush boxes are renewable, and the bushes are very accessible, and give even wear on the commutator.

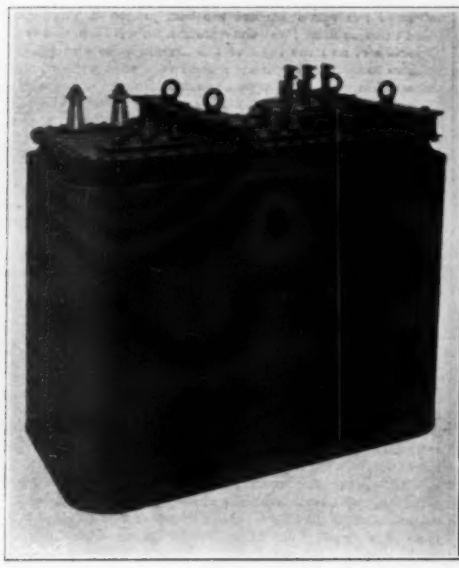


FIG. 2—MAIN TRANSFORMER

FIG. 3—ELECTRICALLY-DRIVEN BLOWER

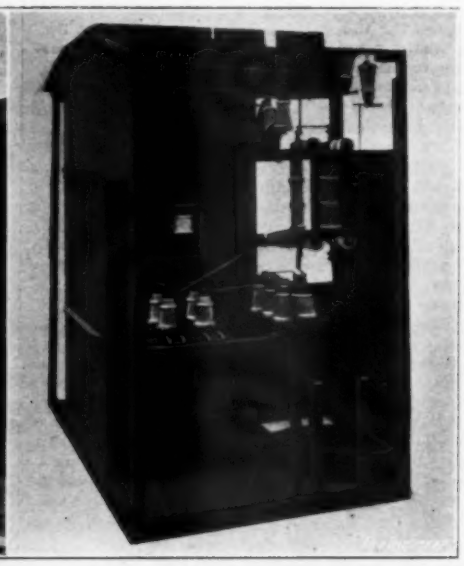


FIG. 4—HIGH TENSION CHAMBER

There is a motor blower unit for each section, and a single motor-driven compressor for the brake equipments and control gear. As shown in Fig. 3, the blower motor drives three fans, one for each motor and one for the transformer, and the blowers can be controlled from either of the driving positions. Mounted on the ends of the coaches are duplicate receptacles and an auxiliary receptacle, and jumpers are provided for joining up the trailer coaches. At

each end of the motor coaches there is a master controller for controlling all the motors throughout the train, and there is also a master controller for the driving trailer coaches. The controllers have seven notches and are provided with the usual "dead man handle." The bow collectors are mounted directly above the bogies, whilst directly below the bow collectors is the small high-tension chamber, as shown in the skeleton illustration—Fig. 4—and in this chamber the oil switch and main and auxiliary fuses are situated. The doors of the chamber are interlocked, so that they can only be opened when the apparatus within the chamber has been made dead and has been earthed. The main transformer is situated directly on the main cross members of the frame, which rests on the bogie, but it is placed slightly out of the centre, so as to allow an uninterrupted gangway from one end of the coach to the other, and it can be lifted out of the coach—as shown in Fig. 5. The low-tension connectors from the transformer to the main contactors are run overhead, and the contactors are mounted in groups and are screened by removable sheet steel covers.

From the foregoing it will be realised that a very compact and accessible general arrangement of the main items has been secured, and as the centre of the coach is free from electrical equipment, accommodation is made available for a guard's van. The driver's cab at each end of the coaches contains the usual control gear, such as the master controller, driver's brake valve and emergency valve, and the switches for the control of auxiliary apparatus and train lighting and miscellaneous gear.

This new electrified section of the Southern Railway formed part of the former London, Brighton and South Coast Railway, and the contracts for the scheme were placed and the work was started before the grouping of the Southern Railways took place, the lay-out of the whole scheme and the preparation of the specifications being carried out by Sir Philip Dawson.

Salving the French Battleship Liberté.

THE disastrous explosion which took place on the French battleship Liberté in the inner roads of Toulon harbour bottom at about 14 m. below water level, with the after part of the vessel and the base of one of the shattered turrets just above water level. After a discussion of various methods of raising the wreck, the system of floating by compressed air was determined upon, and the work was begun about the end of July, 1921. An old cruiser, the Latouche-Tréville, was moored alongside the sunken hull and served as a depôt ship. On her four air compressors—two steam driven and two electrically driven—were installed to supply the air required for the salvage operations. An air lock was constructed in the aftermost turret of the Liberté, and the water was gradually displaced from the interior of the hull until it was possible to reach the magazine and remove the whole of the remaining munitions—some 290 tons—which dangerous operation was successfully completed in February, 1922. In the June of that year two further air compressors were installed. Efforts were made to free the bottom of the wreck from the mud by means of air jets, and a slight movement was eventually noted. Two old submarines of the "Opale" type, each capable of giving a lift of 225 tons when immersed, were then attached to the propeller shafts and the stern post of the Liberté, and on September 29th, 1922, with continued use of compressed air in the interior compartments, the hull began to lift at the stern. Profiting by the inclination of the wreck, further work by divers and workers with compressed air was made possible, and cofferdams were constructed and transverse bulkheads repaired, so that air could be forced into the vessel and more water be expelled. In March, 1923, the rear stokehold was reached, and three months later this and the adjoining coal bunkers were cleared. The ship remained fast in the mud, and it was not until the end of September, 1923, that the second period of the work was entered upon; during this time much trouble was caused by part of a turret embedded deeply in the mud at the port side of the hull. It could not be lifted by crane, and at one period it fouled the bilge keel on the port side of the ship, and hindered the easy manœuvring of the submarine. Eventually four flotation cylinders were added and lift was obtained by mooring a 200-ton coaling vessel transversely across the wreck. The operation was facilitated by placing over 1200 tons of iron ballast in the extreme stern of the wreck. As far as possible all loose metal and a great deal of armour-plate was removed from the ship, but, despite these

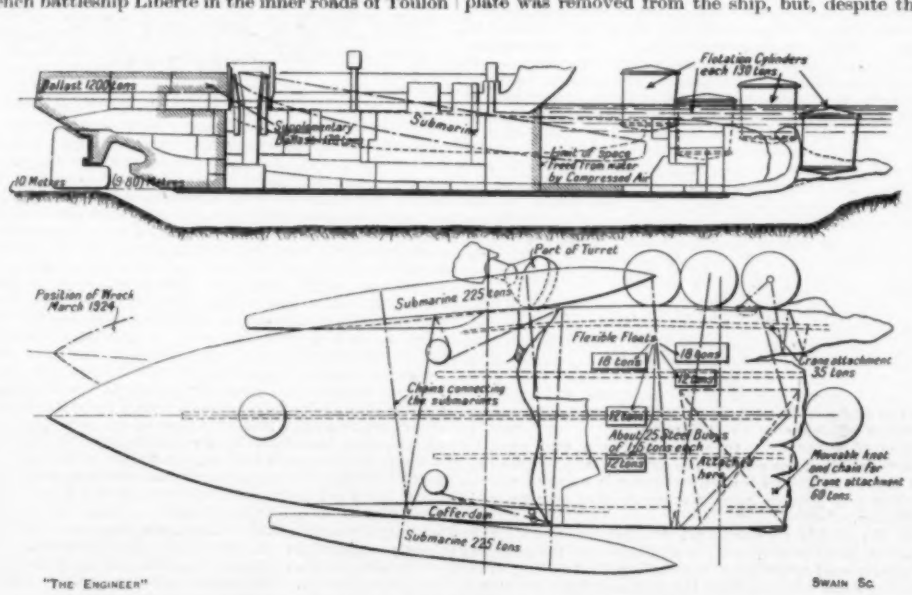


DIAGRAM ILLUSTRATING THE RAISING OF THE LIBERTÉ

making good by the construction of new water-tight bulkheads. Added to this a great deal of ingenuity was shown in the arrangement of the floating vessels, and the work on the whole will take a special place in the history of large salvage operations.

Harbour on September 25th, 1911, will be well within the memory of our readers. The explosion was caused by the ignition of a cartridge of powder in one of the two forward starboard magazines, with the result that practically the whole of the fore part of the ship was blown away, and the bridge and turrets completely wrecked with heavy loss of life. Of the 15,000-ton ship only a wreck of some 7000 tons to 8000 tons remained. As this wreck constituted a dangerous object to navigation in the harbour, the task of salving it has engaged the attention of the French naval authorities for many years, but owing to the war its completion has long been delayed. Indeed, it was only on February 12th last that the remaining part of the hull of the Liberté was refloated, and was towed into the large basin of the Toulon Arsenal there to await demolition.

In an article published in the issue of March 14th of our contemporary, *Le Génie Civil*, Monsieur H. Faure tells the interesting story of the way in which the raising of the hull was carried out. His account is made all the more valuable by the series of excellent drawings and reproductions from photographs which accompany the article. One of the drawings, which illustrates the final stage of the re-floating operation, is reproduced herewith.

The wreck was deeply embedded in the mud of the measures, one corner of the wreck remained fast in the bottom of the harbour.

About the end of October last the final stages of raising were accomplished. An important part of the work consisted in removing pipes and machinery from the condenser compartments and rendering this part and the double bottom beneath free from water. The floating cylinders were arranged as shown in the accompanying illustration, in which the lifting effects of the various appliances is indicated. Besides the steel cylinders a series of Faure flexible floats were used, as well as a number of steel buoys. The lifting operation at the midship part of the wreck was assisted by two cranes, and finally the hull was floated into the position shown in the drawing. When in this position the floating wreck was attached alongside the old cruiser, the Latouche-Tréville, by spars and hawsers, and the supply of compressed air to the internal parts of the ship was thus maintained until the last movement, when the four tugs had safely towed the wreck to the basin.

We have only been able to outline in the briefest manner possible the arduous and patient work which was put into this lifting operation. It comprised not only daring and dangerous diving work, difficult work with compressed air, and much patience in cutting away with oxy-acetylene blowpipes, and

Some Aspects of Low Temperature Carbonisation.*

THIS lecture has for its main object, not a discourse either upon the solution of the smoke problem or a detailed description of low-temperature carbonisation plants, but rather has three aims:—

(1) A brief reference to the difficulties which beset early pioneers in this work.

(2) A classification of the processes for carbonising coal at low temperatures.

(3) The choice of plant in view of the products required.

The difference between the various low-temperature retorts is due to the fact that, having appreciated more thoroughly the fundamentals of the process, the method of attaining the desired object can be carried out in various ways.

DIFFICULTIES OF LOW TEMPERATURE CARBONISATION.

The main difficulty probably lies in the fact that engineers, chemists and others when designing retorts failed to understand and appreciate the properties of coal. From the point of view of preparing a low temperature coke, the properties of the raw material of chief concern are as follows:—

(1) The behaviour of the coal when heated slowly or rapidly to 600 deg. Cent.

(2) The conductivity of the coal for heat.

Coals differ so considerably from one another that it might almost be said that no two are alike. Hence the behaviour of a coal upon carbonisation is influenced by its nature and also by the method and rate of heating. It is not possible to describe here the effect of heat on different coals, but if three cases are briefly described, viz., a non-caking coal, a medium caking coal and a strongly caking coal, it will serve to indicate some of the difficulties of designing a suitable retort for carbonising coal at low temperatures. On heating the non-caking coal, decomposition occurs as the temperature rises, the coal itself does not fuse or soften to any degree, it does not expand whilst the cake is either very weak or almost a powder. In the case of a medium caking coal, decomposition is accompanied by softening and frequently by expansion of the coal, whilst the coke is slightly swollen and fairly strong. Lastly, a strongly caking coal such as was formerly recognised as ideal for the manufacture of metallurgical coke will, when carbonised at low temperatures, yield a highly swollen, very porous, soft coke. It is clear that if each of these coals was carbonised in a closed retort, difficulties would be encountered from the caking coals owing to the expansion and consequent sticking or holding up of the charge. A further point must also be mentioned, viz., that the semi-fused coke offers great resistance to the passage of the gas, with the result that cracking of the tar occurs, whilst the evolution of the gas tends to produce a porous coke. Hence a retort must be of such construction that the gases and vapours evolved can escape as readily as possible and without undue overheating.

The difficulty of the low conductivity of the coal was encountered in the very early history of the industry. In 1880, Scott Moncrieff suggested that low temperature coke should be prepared in gas retorts, but instead of obtaining a semi-coke, the carbonised residue consisted of an outside layer of coke, an inner layer of semi-fused sticky material, and a core of coal which had barely altered. Similar conditions pertain in a modern coke oven where, with a flue temperature of 1200 deg. Cent. or over, it is several hours before the centre of the charge reaches red heat. Hence the tendency is towards a much narrower oven. In the preparation of low temperature coke where the flue temperature lies at about 600 deg. Cent., the transference of heat is much slower and the necessity for a narrow oven becomes far more imperative. Hence it has become an axiom that the coal must either be heated in thin layers or other means adopted for conveying heat through the coal, and the various methods of attaining this object are classified below.

The engineering difficulties have purposely been omitted here, since these may be gathered to a certain extent from what has been mentioned above and from the classification of the retorts. The actual construction of the retorts has had of necessity to be omitted or only referred to very briefly.

CLASSIFICATION OF RETORTS.

As a result, chiefly in the first case of the "hit or miss" principle, a large number of differently designed retorts have been suggested and tried for carrying out the process; some, in the light of present knowledge, doomed to failure almost from the beginning, others developing into methods which now bid fair towards large scale success.

It is not intended to describe the different plant which has been tried or which is now in operation or undergoing construction for carbonising coal at low temperatures, but a classification of these processes and a brief reference to a few typical retorts will indicate the variety of plant which is being employed for low temperature carbonisation.

Retorts may be divided into four main classes according to whether the heating is performed by external or internal application, and whether the process is continuous or intermittent. Thus:—

(1) *Externally Heated Retort with Intermittent Feed.*—This method of performing the process is the one which would suggest itself upon first examination of the problem. It is comparable with the method of manufacture of metallurgical coke in closed ovens, heated externally, and of

* Lecture delivered before the Hull Chemical and Engineering Society, on February 27th, 1925, by Mr. N. Simpkin, Director of Research to the Lancashire and Cheshire Coal Research Association.

ordinary town's gas where the same principles underlie the method of carbonisation. Parker's original process belonged to this class of retort. W. D. Scott Moncrieff, writing in *Nature* in 1880, has this method of carbonisation in mind when he suggested that gasworks, instead of obtaining 10,000 cubic feet of gas per ton of coal carbonised, should carry the distillation so far as to yield only a third this amount, pass three times the amount of coal through the retorts, and obtain a richer gas and a coke which would be suitable for domestic purposes.

The present coalite retort belongs to this class, but it has undergone considerable changes in view of the experience and knowledge gathered in the last few years. The latest retort consists of an iron casting containing twelve vertical tubes, each 9ft. long, 4½in. in diameter at the top and tapering to a diameter of 5½in. at the bottom to facilitate removal of the coke. The retorts are externally heated by means of the gas produced from the process, and owing to this arrangement, no part of the coal undergoing carbonisation is far removed from the source of heat.

(2) *Externally-heated Retorts with Continuous Feed.*—This type of retort might be said to follow on from the previous one. Having produced a retort which would carbonise coal at a low temperature, the next step was to make the retort continuous in its action. This, however, was not so easy as would appear at first, the large number of retorts of this class bearing witness to this point and indicating the numerous methods by which it was hoped to overcome the difficulties arising. One of the main difficulties attending the operation of a continuous process is the fact that with many types of coal the fuel will not "flow" through the retort. If the material to be carbonised is of the nature of a shale or a non-caking coal, the problem is not so difficult, but the resulting product, on the other hand, is useless as a domestic fuel, as it comes direct from the retort. A coal which is strongly caking and swells on carbonisation sticks in the retort and renders ordinary retorting processes useless.

To overcome these difficulties many different retorts have been constructed and have, to a large extent, solved the problem. These may be outlined briefly as follows :—

(*a*) Retorts constructed upon the principle of a tunnel kiln, the coal passing through a seated zone in suitable containers.

(*b*) Retorts in which the coal is caused to move by means of its own weight, the retort being vertical and fed from the top, the carbonised product being withdrawn at the bottom.

(*c*) Retorts in which agitation of the coal is produced by the rotation of the retort itself, on the principle of a cement kiln, the retort, however, being heated from the outside. The coal passes through the retort, owing to the inclination of the retort, the material to be carbonised being fed in at the higher end. The "Fusion" retort operates upon this principle.

(*d*) Retorts in which the coal is forced through the retort mechanically by means of rotating arms or other suitable arrangements. As an example of this the primary retort of the Carbocoal process may be taken as an example.

(3) *Externally and Internally-heated Retorts with a Continuous Feed.*—These are based upon the principles underlying the retorts used for treatment of brown coals and oil shales.

(4) *Internally Heated with Continuous Feed.*—This method differs essentially from those above in that the heat required to carbonise the charge is derived by bringing the latter into contact with a hot gas or liquid which carbonises the coal by its own sensible heat. Retorts of this type may be subdivided into three classes :—

(*a*) Where heating is performed by means of superheated steam which passes through the charge. Parker's original process embodied this idea, his patent of 1890—this was not his master patent, which was only taken out in 1906—claiming the production of a smokeless fuel by passing steam, water, gas or coal gas superheated to a temperature of 600 deg. to 650 deg. Cent. through a mass of coal in a retort. Other processes, *e.g.*, the Pure Coal Briquette Process, a plant for which is in course of erection at Leigh, Lancashire, are performed by this means. In this process the coal is first pulverised and then briquetted without binder. By careful selection or blending of the coal, briquettes can readily be obtained which retain their shape, are quite hard, do not adhere together in the retort, and burn readily.

(*b*) Where the heat is supplied by hot producer gas or combustion products, as an example, the Nielsen retort ought to be mentioned. The retort itself is a large horizontal cylinder, capable of rotation and slightly inclined to cause the coal to pass through the retort. The lower end is connected to a producer, the hot gases from which pass through the retort and so carbonise the charge. In the Maclaurin plant in course of erection at the Dalmarnock Gasworks of the Glasgow Corporation, the heat is generated in the coal itself. The retort consists of a producer not unlike a blast-furnace in shape but built square. Steam is blown in at the bottom. This cools the coke and as the steam passes upwards the charge it reaches the combustion zone, where air is drawn in through port holes. Producer gas is generated, and this supplies the heat necessary for carbonisation. In the coal above the combustion zone, distillation is in progress, and the temperature falls gradually towards the top, where arrangements are made for collecting the tar evolved. A number of by-product recovery producers and generators yielding a mixture of coal gas and water gas are constructed broadly on these lines, but there is no attempt at the recovery of a low-temperature coke.

(*c*) Where heating is performed by a hot liquid. The outstanding example of this is the Piron-Caraoristi process operated by the Ford Company. The retort consists of a double chamber furnace lined with refractory material and provided with a bath of molten lead maintained at the desired temperature for carbonisation. A floating conveyor carries the coal over the hot lead, where carbonisation occurs, and then discharges the product on to a second conveyor which removes the coke for storage.

SELECTION OF PLANT.

It will be seen from the above that there has been considerable enterprise and experiment in developing a process or processes to carbonise coal satisfactorily at low temperatures, and the question may well be asked as to which is the most satisfactory method. This cannot be answered without due consideration of a number of factors, among which the following are perhaps the most prominent :—

(1) The nature of the material to be carbonised.
(2) The object in view, *i.e.*, whether a low temperature coke, the tar or the gas or all three are products desired.
(3) The efficiency and ease of working and control of the retort itself.
(4) The cost, which is wrapped up and connected with each of the above.

(1) *Nature of the Material to be Carbonised.*—Attempts have been made to carbonise at low temperatures, a variety of carbonaceous substances ranging from lignites, brown coals, bituminous coals of various types to shales and waste products, such as colliery refuse.

Considering the wide differences in nature and behaviour of these materials on heating, many designers of plant were well justified in constructing a retort with the object of dealing with only one class of material, whilst other retorts have been constructed to handle materials varying considerably in nature, and are consequently more "elastic" in operating upon different types of coal, &c.

As lignites and brown coals do not come within the range of raw material which can be obtained in England, it is proposed to deal chiefly with bituminous coals, shales, &c. Bituminous coals vary in nature, some being strongly caking and ideal for coke manufacture. These, as a rule, are low in volatile matter, expand on carbonisation, and yield a strong coke at high temperatures. Others yield a high percentage of volatile matter, shrink on carbonisation, and yield a very weak coke. Between these two limits, there are various types, some yielding slightly swollen cokes, of medium strength. It must be remembered, however, that coals frequently behave very differently when carbonised at low temperatures, say, 600 deg. Cent., to what they do at high temperatures, and a coal which yields a firm strong coke under the latter conditions, may, when carbonised at low temperatures, give a coke totally unsuitable for many purposes owing to its great porosity and friability.

Obviously a coal which expands considerably upon carbonisation at low temperatures cannot be handled satisfactorily in a retort where no allowance is made for this property of the coal, and as such coals almost invariably give rise to a well-fused porous coke, great difficulty would be experienced in removing the matter from the retort. A coal of this type would of necessity have to be carbonised in a retort where due allowance was made for expansion, *e.g.*, a rotary retort, or in the alternative, the properties of the coal would require modification by blending with a non-swelling coal of low caking quality.

Shales vary widely in nature and behaviour on carbonisation, but the great swelling properties characteristi of many coals are absent. It has often been proposed to subject colliery refuse to some form of low temperature carbonisation, and thus utilise a material which is at present unsaleable and to all intents and purposes useless.

Colliery refuse consists of washery dirt, carbonaceous shale, fines, &c., which owing to their nature are usually very low in caking qualities, possess a high moisture and ash content, and can only be considered as of very doubtful material as far as low temperature carbonisation is concerned. The carbonised residue would in most cases be useless for direct consumption as a fuel, unless its ash content permitted of its use as pulverised fuel, whilst the tar yield would tend to be low. The coke might in certain circumstances be employed for the generation of producer gas, but it must be recognised that in most cases the ash content is very high.

(2) *The Object in View.*—This may be subdivided into several classes, the most prominent but perhaps not the most important being the production of a smokeless, low temperature coke. If this is to be used direct for domestic consumption, the coke must be sufficiently hard and strong to stand handling, whilst at the same time it must be of low ash content. Hence careful selection and, if necessary, blending of the coal must be made. If the coke is briquetted subsequent to carbonisation a coal may be used which does not possess the required coking qualities, but if briquetting with a pitch binder is resorted to, the product will require further carbonisation to render it smokeless.

In the Smith or Carbocoal Process, in operation in America, the low temperature carbonisation is performed in a horizontal retort fitted internally with rotating shafts carrying arms which agitate the coal and force it through the retort. The semi-powdered coke is then briquetted with a pitch binder and recarbonised at a high temperature.

Reference has already been made to the Pure Coal Briquette Process, where the powdered coal is first briquetted without binder and subsequently carbonised, the coal being selected so that undue expansion and consequent disintegration of fusing together of the briquettes in the retort does not occur.

It will be seen that a retort must be chosen which will yield a coke in a form suitable for the purpose required.

If it is not intended that the coke be used for domestic consumption considerably more latitude is permissible, both in the coal employed and the type of retort. In the first place much poorer qualities of coal, from the point of view of ash content and of caking qualities can be utilised, whilst the coked residue can be employed either for industrial purposes, for firing on chain grate and other mechanical stokers, or may be pulverised and utilised in the form of powdered fuel for firing boilers, furnaces, cement kilns, &c. This latter mode of treatment has certain advantages ; the coke, provided a suitable coal is used, requires very little grinding ; previous drying, which has to be resorted to in the case of many coals, is unnecessary ; the material can be stored if desired without fear of spontaneous combustion, and whilst insuring smokeless combustion, the by-products are obtained by the previous low temperature treatment.

Certain processes operate with the primary object of obtaining not a smokeless fuel but the tar and ammonia followed by the complete gasification of the carbonised residue. In such instances, the retort is usually of the type belonging to class 4 above, *i.e.*, internally heated and a continuous feed. If producer gas is employed as the heating medium, no attempt is made to separate this from the rich gas evolved, whilst the carbonised residue is subsequently gasified. In a combined plant of this type, the ultimate yield of ammonia—or ammonia sulphate—is very high as compared with the other processes, particularity if excess steam is used in the producer. It must be clearly understood that by ordinary low temperature carbonisation, yields of sulphate above, say, 12 lb. to 14 lb. cannot be obtained unless temperatures above 600 deg. Cent. are employed. Certain processes, *e.g.*, the Maclaurin retort will yield higher figures, but here the temperature in part of the retort exceeds the figure stated. Furthermore, the recovery of small amounts of ammonia may not repay the cost of the operations involved. Difficulties may also be encountered in disposing of a weak ammoniacal liquor which cannot be economically worked up for sulphate.

(3) *The Efficiency and Ease of Working and Control of the Retort Itself.*—It is scarcely necessary to state that the economy of the retort should be as high as possible. With this in view, the essentials of a satisfactory process may be summarised briefly. The retort or battery should be capable of dealing with large quantities of coal, and the process should either be continuous or the charging and discharging of the retort should be capable of being performed in a comparatively few minutes so as to avoid loss of heat and irregularity. The through-put should be as high as possible compared with the size of the plant, and temperature should be capable of easy control so that uniformity is obtained in the product. Reference has already been made to the removal of tar vapours from the hot zone and tar vapour evolved at any temperature should not be subjected to higher temperatures. The consumption of gas for heating the retorts must be as low as possible. Since coal is a very poor conductor of heat, the coal should theoretically be carbonised in thin layers. The failure of many of the earlier retorts was due solely to the fact that insufficient attention was paid to this point alone.

(4) *The Cost.*—The cost of the process is influenced not only by the actual initial cost of the plant and its running costs, but upon a number of external contributory factors. Among these may be mentioned the facilities for obtaining suitable coal at a satisfactory price, and the means or disposal of the products. The coke, if intended for household consumption, must satisfy requirements as to hardness, low ash content and price. The income from sale of sulphate may, as mentioned above, be very problematical in certain cases, owing to the cost of working up the liquor obtained. If the retort is such that it yields a small quantity—approximately 3000 cubic feet of a rich gas—this may be sold for enriching town's gas, if local conditions permit, or it may be employed for heating the retorts. When the former case is adopted, other gas, *e.g.*, producer gas, is required for heating the retorts. Processes which give a very high yield of enriched producer gas will again be dependent upon local conditions for disposal or utilisation for furnaces, &c. &c.

SIXTY YEARS AGO.

THE care of the worker's health, it is to be feared, was a subject which sixty years ago received little attention, either from the Government or the employers. Little indeed was known, compared with the knowledge of the subject which we have to-day, as to the incidence and nature of occupational diseases. In a leading article in our issue of April 28th, 1865, we discussed the health of engineering workers. The healthiest of all engineering workers was, we held, the railway navvy. Working always in the fresh air and fed with good beef and mutton, the railway navvy, we wrote, was perhaps as a class the finest human animal in the world. Machinery erectors, fitters and turners also followed a healthy occupation, provided they had not much brass filing or turning to perform. Brassfitters and moulders were noticably pale, and often had a perceptible green tinge about the hair of the head. The best means of counteracting this evil effect of verdigris was, we said, to drink plenty of good milk. The dangers attendant upon the grinder's occupation, now so closely studied and controlled by law, were very briefly mentioned. All that was said on the subject was that "the dust which fills the shop wherever an old-fashioned grindstone is turned down must also be unwholesome." We seemed to be more impressed with the danger of the stone bursting than with that arising from the dust. Men constantly engaged in cutting screws and nuts with their hands and clothes soaked in rank oil were generally biliously affected. Boilermakers were mostly healthy, although sooner or later they became more or less deaf. Smiths were less healthy, being liable to take colds and to suffer from affections of the liver. The most unhealthy of all the occupations in an engineering workshop was, we argued, that of the draughtsman. The cramped, confined position in which he had to work, and his generally long hours, soon told on his constitution. In some establishments, especially in the North of England, the draughtsman of that day, it seems, worked from 8 a.m. to 6 p.m., or even 6.30 p.m., with an hour off for dinner. In London, however, the hours were generally only from 10 a.m. to 5 p.m. For a man of some education, we concluded, the chances of advancement were at least as great in the workshop as in the drawing-office. The vice, moreover, offered a greater likelihood of long life than the drawing board. Fitters did get old, but an old draughtsman was as rare a being as an old post-boy or a dead donkey.

THE railway results for January last, as indicated in the Stationery Office publication, Railway Statistics, for January, 1925, appear in a favourable light in consequence of their comparing with a period in which there was a ten days' partial stoppage of the railways owing to a strike of enginemen. The number of passenger journeys was 15.7 per cent. more, and the passenger receipts showed an increase of 16.5 per cent. The coaching train miles were 18.3 per cent. higher. There was an increase of 4.6 per cent. in the freight tonnage, of 12.6 per cent. in the ton-miles, and of 10.5 per cent. in the freight receipts. The last were earned by 18.9 per cent. more train miles, and the average train load fell from 138 tons to 131¼ tons, and the net ton-miles per engine hour from 443½ to 423½.

Railway Matters.

THE Glasgow Corporation is purchasing a quantity of special tramway track material in the United States.

IT is proposed to construct a new tramway route in Edinburgh between Newington Station and West End *vid* Melville Drive.

IT is reported from Amsterdam that the Administration of the Dutch railways intends shortly to introduce on certain railway lines petrol-driven motor carriages.

THE London and North-Eastern Railway Company, in a letter to the North London Travelling Facilities Committee, states: "The electrification of the Great Northern section of our suburban lines is the subject of active inquiry."

THE work of diverting the permanent way on to the new bridge over the Liverpool–Leeds Canal between Leeds and Holbeck, has now been begun by the London, Midland and Scottish Railway. It is expected that this important undertaking will be completed by Whitsuntide. The existing bridge, will, it is hoped, be rebuilt in the near future, and when that big task is completed, there should be a very considerable improvement in the traffic facilities on this heavily-used line. The new bridge is over 100ft. wide, and the main girder weighs 125 tons.

THE third annual report of the Railway Rates Tribunal, just issued, expresses disappointment with the progress made in 1924 towards the settlement of the schedules of standard charges. The Tribunal appreciates the great complexity of the questions in issue and their vital importance to all parties, and realises the vast amount of work involved. The members think, however, that "the time has arrived when it would expedite the proceedings and be of assistance to all parties if we indicated the various remaining stages which we consider necessary for the settlement of standard charges, and the dates when we will sit to consider such stages. It is our intention therefore to inform the parties at an early date of the stages and dates which we have determined and to fix a day when any observations thereon will be heard."

IN order to compete with river shipping companies which have hitherto been conveying across country goods at much cheaper rates than the German railways, the latter have reduced their rates for the transport of steel and iron to German shipyards by roughly 30 per cent., thus bringing the rates for these articles to the pre-war standard, although they are still higher than shipping rates. It is declared that this reduction does not infringe Article 365 of the Treaty of Versailles, because, according to Article 378, the granting of the most-favoured nation treatment to the Allies in respect of railway tariffs expired on January 10th. It is possible also that the railways will reduce the freights on coal from the Ruhr in an effort to take trade away from the river shipping companies, but at present no decision has been reached on this point, although negotiations on the matter are taking place.

IN this column of our issue of December 12th last we mentioned that the Great Western Company had come to an agreement with the National Union of Railwaymen as to the steps to be taken to avoid men being dismissed owing to the serious falling off in the coal traffic in South Wales. Matters in the latter respect have now got so much worse that the company will have to take some steps to reduce its wages bill, and has submitted to the sectional councils proposals for (*a*) suspending the guaranteed day and week; (*b*) dismissing men; and (*c*) effecting a reduction in pay for all grades on a percentage basis. The London and North-Eastern Company has followed the example of the Great Western. The proposals of the former company are less definite than that of the Great Western. It is stated that the position has become so acute that it may not be possible in the near future to find work for all the men at present employed, and that the railway shops are to be placed on short time. There are not, however, any proposals at present to interfere, as suggested by the Great Western, with the guaranteed week, to discharge men and to effect an all-round reduction in wages. Speaking at Newcastle the other day, Mr. J. H. Thomas —we note with satisfaction—said with regard to the all-grades programme submitted to the companies last December, "Our task in conducting the negotiations will be a very difficult one. I am not going into the negotiations with the idea that the only solution is a railway strike. I am gong into those negotiations with a single-minded desire to effect an honourable settlement."

THE first of the London tube railways on which, from the start, the trains were protected by automatic signalling, was the Baker-street and Waterloo. It was opened on March 10th, 1906, and other tubes and their extensions have since then been brought into use, similarly signalled. During that period of nearly twenty years only three collisions have called for inquiry by the Government inspecting officers. The last of them occurred on the Charing Cross loop on January 19th last, and the report on it by Major Hall has just been issued. For reasons that need not be explained, a south-bound train had to be reversed at the Strand Station, so that it could proceed north-bound without going over the loop. The overall wheel base of the train was 347ft. 5½in., and the space available up to the starting signal was only 341ft. 6in. The train had, in consequence to draw past the starting signal at "danger" in order that the crossover-road could be opened for it to reach the other line. Immediately after that preliminary movement had been made the instructions were cancelled and the station staff and trainmen given "Right away to Charing Cross." These men, except the motorman, saw that the signal was "on," but assumed that that condition was due to the head of the train being past the signal; it was, however, in consequence of the section being occupied by another train. The motorman could not see the signal and, in the absence of an advice to the contrary, concluded that the signal was "off." He let his train proceed, and it ran into the previous train, injuring one passenger and one servant. Major Hall acquits the motorman of all blame, and recommends that as seven-car trains are about to be more generally used the starting signal be carried further forward.

Notes and Memoranda.

THE pipe line for supplying Port Sudan with water from wells at Khor Arbast has been completed. The pipe ranges from 6in. to 8in. in diameter, and crosses 18 miles of desert.

A WORKSHOP instructor is to be appointed to the Technical Institute at Coventry, to which the Daimler Company and Alfred Herbert have already given machinery of a total value of £2200.

IT is proposed to install pumping plant to increase the flow through the water main which supplies Barnsley with water from the Midhope reservoir. The flow is at present 1,900,000 gallons a day, and it is to be increased to 2,800,000 gallons.

ACCORDING to Dr. C. H. Lander, Director of Fuel Research to the Department of Scientific and Industrial Research, the Scottish shale oil industry, no matter how pushed, could never supply more than 10 per cent. of our requirements in liquid fuel.

ACCORDING to Commander Burney it should be possible to maintain a six and a-half days' airship service between England and New Zealand, with only three intermediate stations—at Bagdad, Colombo and Fremantle or Perth. A 5,000,000 cubic feet airship, with an average speed of 70 miles per hour, would be needed.

A TEST of the new roofing material Pyropruf, to show its fire-resisting qualities was recently made at the London County Council stores depôt, Pimlico, in the presence of a number of interested officials. The tests included comparison with roofs of slate and tiles, and are said to have shown the superiority of the new material.

THE annual return of shipping and tonnage in the Suez Canal for 1924 shows that the sea-borne traffic consisted of 5122 vessels of a gross tonnage of 34,651,932, the transit receipts totalling 186,460,813f. Ships flying the British flag supplied 59.6 of the total percentage of gross tonnage; followed by Dutch vessels with 9.9; German, 6.6; French, 6.3; Italian, 5.9; Japanese, 3.5; and American, 3.1.

DURING the annual overhaul of the liner Montrose at the Beardmore Engine Works, Liverpool, which has just been completed, one of the main gear wheels of the double-reduction gear was replaced. The work entailed the removal of the hatchway and a large amount of piping, &c. The heaviest lift was 52 tons, and was effected with temporary tackle. In spite of the extent of the work, it did not delay the liner any longer than the usual overhaul.

THE production of pig iron in this country in March amounted to 607,900 tons, compared with 541,900 tons in February and 668,600 tons in March, 1924, the increase compared with February being mainly due to the longer month. The furnaces in blast at the end of the month numbered 169, a net increase of four since the beginning of the month. The production included 199,400 tons of hematite, 199,600 tons of basic, 148,900 tons of foundry, and 27,500 tons of forge pig iron. The production of steel ingots and castings amounted to 684,700 tons, compared with 652,300 tons in February and 816,900 tons in March, 1924.

ACCORDING to the *Electric Railway Journal*, the Department of Street Railways for the City of Detroit, Mich., has adopted the practice of coating the inside of motor frames and the field coils with insulating varnish after the coils have been assembled. The varnish is applied with a home-made spraying arrangement, which has two flexible connections, one for the air supply and the other for the varnish supply, both of which are controlled by the operator by means of valves arranged conveniently in the connections. The varnish is sprayed around the field coils and other parts of the frame where flash-overs are likely to occur.

A PAPER accepted for publication in the *Journal* of the Institution of Electrical Engineers, deals with the losses involved in the distribution of alternating-currents in sheathed cables in which the sheath is of magnetic material. Single-core rubber-insulated cables, each enclosed in a separate iron tube, and also single-core cables armoured with one or two layers of galvanised iron or steel wires, are dealt with, and experimental data are given showing the measured losses in each case. It is shown that, while the losses due to induction in a tube are considerable, those in a wire-armoured cable are comparatively very small, and also that the distance separating the individual cables forming a circuit has very little effect in determining the losses involved. In the case of the wire-armoured cable, also, the connection of the sheaths of separate cables so as to form a closed sheath circuit has no appreciable effect upon the losses, and the current which will flow in such a circuit is so small as to produce no considerable heating. The paper is by Mr. C. M. Harvey, associate member, and Mr. A. H. W. Busby, student.

FOR the improvement of aeroplanes and their flying characteristics, it is of the first importance to be able to measure, not only the movements of the aeroplanes, but also the movements of the controls which bring about the various manœuvres through which an aeroplane can be put. There are several methods of attaining this end. Whereas the Americans have used one instrument on which a number of simultaneous records are kept, the Royal Aircraft Establishment has designed a type of recorder, one of which is fitted to each control. From many points of view, the British method appears to be preferable. The recording instrument is described in a report published by the Air Ministry (R. and M. 942). It gives a continuous record of the movements of any control surface of an aircraft during manœuvres. It has been designed so that it can be directly attached to the surfaces, thus avoiding any error caused by elasticity in the control wires, &c. One instrument has been subjected to some fifteen hours' flying, involving about thirty separate flights, and has, it is stated, given every satisfaction. A reproduction of a portion of one of the records obtained is attached to the report. For research work at the Royal Aircraft Establishment, it is proposed to fit these instruments to all the control surfaces of an Avro machine, together with a gyro instrument to record the rate of turn about the three axes.

Miscellanea.

IT is proposed to replace two old turbine sets of 5000 kilowatts capacity in the Wolverhampton power house by a new 7500 kilowatt turbo-generator set, at an estimated cost of £44,000.

IN connection with the proposed erection of a beet sugar factory at Wellington, at a cost of some £350,000, it is stated that practically the whole of the local farmers have pledged themselves to grow beet.

THE official tests in connection with Sir Charles Markham's offer of a £1000 prize for the best electric locomotive for underground haulage, are to take place at the Brodsworth Colliery, near Doncaster, on May 4th.

IT is reported that the steamer Wellfield, which was in the Hebburn Dry Dock of Hawthorn, Leslie and Co. when it was accidentally flooded last week, has suffered very little damage, and has settled down on the blocks again safely.

IT is intended to undertake a Life of the late Dr. W. H. Maw, engineer and scientist, and editor of *Engineering*. Those of his personal friends, colleagues or correspondents who may have interesting material, especially in the shape of personal reminiscences or letters, to contribute, are requested to communicate with Mr. W. E. Simnett, care of the Institution of Civil Engineers, Great George-street, London, S.W. 1.

THE conference held at Hoddesdon in September, 1924, on special libraries and information bureaux has resulted in financial support being obtained from the Carnegie United Kingdom Trustees for a period of two years, in order to give the new movement an opportunity of becoming self-supporting. Mr. G. W. Keeling, of London, formerly of Winchester and King's College, Cambridge, has been appointed organising secretary. Active arrangements are being made for the preparation of a directory of special libraries and information bureaux for the United Kingdom.

THE New York office of the United States Shipping Board recently announced the award of contracts for thirty-seven auxiliary engines to be used in connection with Diesel installations in fourteen steamers, which are to be converted to motor ships. Nine engines will be built by the McIntosh and Seymour Corporation for a total of 144,150 dollars, the Worthington Pump and Machinery Corporation will construct six for 88,830 dollars, while twenty-two will be built by the Pacific Diesel Company for 277,325 dollars. The vessels upon which the engines are to be installed are being prepared for conversion.

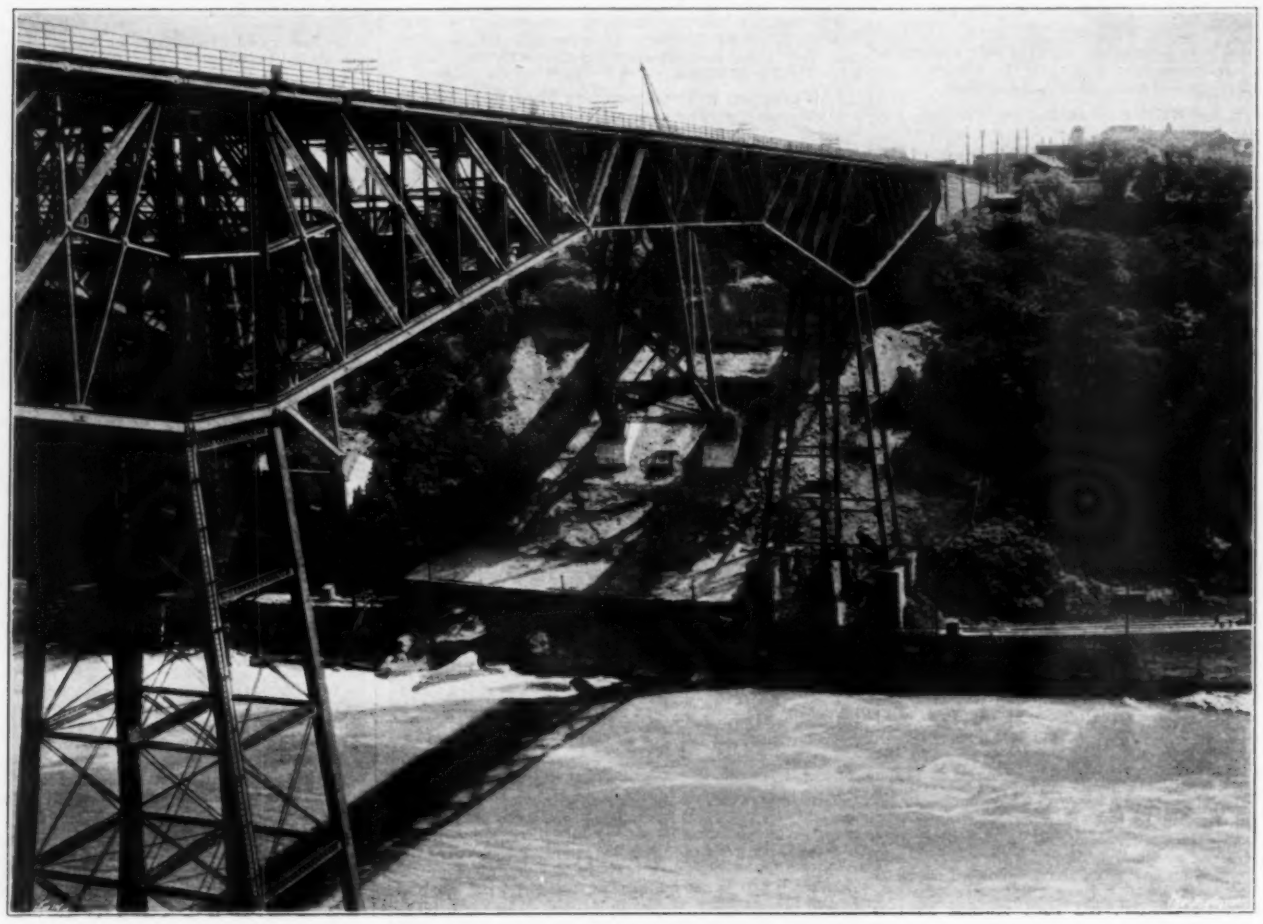
AS a result of agreements reached among scientists as to the fundamental causes of corrosion, a Corrosion Institute is to be formed in America, and an effort to stop the ravages of corrosion will be made by the Institute, with the support of both the users and producers of metal products. The cost of replacing every year in the United States metal structures which fail because of rusting has been estimated by the experts at 300 million dollars. All the metal produced in Great Britain, it is said, would be insufficient to replace the steel and iron structures which fail annually throughout the world because of rusting.

THERE is a gradual change taking place in the goods and passenger transport of this country, owing to the increasing use which is being made of the roads, and changes which take place in the laws controlling it are very naturally of interest to those in the tire trade, says the *Dunlop Gazette*. The Ministry of Transport is shortly bringing a Bill before Parliament which will permit an increase in the maximum speed of heavy vehicles equipped with pneumatic tires, and if it becomes law no doubt more vehicles will be equipped with the giant pneumatic tire. Increased speed will throw more strain on these tires, and will need the utmost care in design and construction. In addition to the alteration in the speeds of heavy vehicles, it is proposed to abolish the speed limit for ordinary cars, which, fixed as it is at 20 miles an hour, has long been ridiculous and a nuisance to road users. There are to be increased penalties for reckless, negligent or dangerous driving, which have for some time been necessary, and it is proposed to render the display of a rear light on all vehicles compulsory.

THE potential water energy of the world is estimated at 453,000,000 horse-power by the United States Geological Survey in a review just issued. The developed water power at the end of 1923 is placed at about 29,000,000 horse-power, according to the best information available to the Geological Survey. This represents an increase of 26 per cent. in the three years following 1920. Europe as a whole has, states the review, beaten the United States in the rate of development of water power, this development having been forced on all European countries, except Great Britain, by the high price of coal. The increase in water power development in the United States, although it is now going forward more rapidly than ever before, shows a percentage of increase less than that in Europe, Japan and the world as a whole. Estimates of water power for the several countries, particularly estimates of potential water power, are difficult to co-ordinate, because of differences in their elements and character, and in the completeness and accuracy of the data on which they are based, but a rough idea of the potential water power resources of the world is given in the review. In Europe, France leads in developed water power with 2,100,000 horse-power, while Norway has the largest potential water power with 9,500,000 horse-power. The British Isles are credited with 250,000 horse-power developed and 850,000 horse-power potential. Japan has the largest developed water power in the Asiatic field, with 1,694,000 horse-power, while the potential force is placed at 4,500,000 horse-power; India has the largest potential force, with 27,000,000 horse-power, in Asia; while China is second, with 20,000,000 horse-power. Africa leads all continents in potential water power, with a total of 190,000,000 horse-power, the Belgian Congo and Belgian Mandate coming first with 90,000,000 horse-power. The Union of South Africa is credited with 5000 horse-power developed and 1,600,000 horse-power potential.

BRIDGES OVER THE RIVER NIAGARA

(*For description see page 492*)



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Contents.

The Engineer, May 1st, 1925.	PAGE
A Seven-day Journal	477
The British Steam Railway Locomotive from 1825 to 1925. No. XVIII. (Illus.)	478
A High-voltage Testing Laboratory. (Illus.)	481
Institution of Mechanical Engineers	483
Vibration in Engine Test Gear. (Illus.)	484
Swiss Railway Electrification	485
Letters to the Editor—	
The Use of Electricity	485
Airship Development	485
Dolius and Sycamore	485
New Single-phase Equipment for the Southern Railway. (Illus.)	486
Some Aspects of Low-temperature Carbonisation	487
Sixty Years Ago	488
Railway Matters	489
Notes and Memoranda	489
Miscellanea	489
Leading Articles—	
Oil Engine Difficulties	491
The Locomotive Trials	492
New Bridge over the Niagara. (Illus.)	492
Literature	493
Propeller-jet Marine Propulsion. (Illus.)	494
Bombay Water Supply—Tansa Completion Works	495
A Century of Gas in South London	496
A Motor Workshop Wagon. (Illus.)	496
An Electric Lighting System for Collieries. (Illus.)	496
A Miniature Radial Drilling Machine. (Illus.)	497
Launch of the Conte Biancamano. (Illus.)	497
H.M.S. Triumph and her Cylinder Liner. (Illus.)	498
A New Relay. (Illus.)	498
Garratt Locomotives for South African Railways	498
Provincial Letters—	
The Midland and Staffordshire	499
Lancashire	499
Sheffield	500
North of England	500
Scotland	501
Wales and Adjoining Counties	501
Personal and Business Announcements	501
Catalogues	501
Current Prices for Metals and Fuels	502
French Engineering Notes	503
British Patent Specifications. (Illus.)	503
Forthcoming Engagements	504
Contracts	504

THE ENGINEER.

MAY 1, 1925.

Oil Engine Difficulties.

An impartial examination of the steps by which any new branch of engineering has advanced, will reveal the fact that much time and money might have been spared, and more certain progress made, had it only been possible to evaluate and apply quickly the knowledge obtained from difficulties encountered and overcome in early development work. This is perhaps especially true of the heavy oil engine industry, which, alike as regards its land and marine branches, has attained so great an importance during the past ten years. The continued necessity for exchange of opinions and constructive criticism in considering problems of oil engine design and operation was recently referred to by Mr. J. L. Chaloner, who was the guest of the Diesel Engine Users' Association at a luncheon held prior to its meeting on April 17th. Passing in review some of the events which led up to the formation of this active and useful body, which includes both users and manufacturers, Mr. Chaloner spoke of the value of the early free and informal discussions of engine troubles, and expressed his regret that recently there had been perhaps a tendency in the direction of the selection of more academic papers with fewer communications dealing with engine defects and running and maintenance problems. In seeking to spur on constructive criticism, Mr. Chaloner complained that he received little help from the perusal of articles in the technical Press, which generally were descriptions of successful installations, and but rarely gave accounts of oil engine breakdowns and running difficulties.

We find ourselves in full agreement with Mr. Chaloner in this matter of the publication of fuller information concerning oil engine defects, and the measures taken to remedy them. At all times we are happy to consider such articles, which are not only keenly interesting to our readers, but are of undoubted value to the industry as a whole. Unfortunately, we generally find engine builders and engine users very reluctant to furnish details when it is desired to give an objective, yet sympathetically appreciative, account of a breakdown or a repair job of unusual interest. In fact, serious failures which unofficially we know to have involved questions of design and metallurgical practice are sometimes glossed over by the makers referring to them as merely difficulties of detail inherent in any new design of machinery. Probably one of the main reasons why the members of the Diesel Engine Users' Association have fewer failures to report is that many early difficulties have been investigated and their causes removed. Wisely, the Association is now devoting some of its energy to the no less important work of collecting and analysing data relating to the running and maintenance costs of generating plant. In looking through the series of papers read before the Diesel Engine Users' Association during the last ten years we note important contributions on the subject of light and heavy fuel oils, and the problems associated with the lubrication of engines and air compressors. Engine details have not been overlooked, and crank shafts, connecting-rod bolts, cylinder and piston cooling systems, air compressors and intercoolers, and the care and maintenance of oil engines have all been thoroughly dealt with. Information is now to be sought, we understand, on the question of the amount of lubricating oil which is used and burned in engine cylinders. With the advent of high-power double-acting engines for power station work, new problems will emerge, but if they are dealt with and discussed in the same broad-minded way, they will certainly be speedily overcome. What we have just said applies to engines for land work mainly, but in the marine branch of the industry the rate of progress has been even more swift. So far, there has been little attempt on the part of shipowners, marine superintendents and engine builders to co-ordinate and discuss with each other difficulties met with in design and service. That such work is urgently needed, is, we think, very clear. If we take the important question of cast iron for cylinders and liners, little has been published as yet on the research work which has been done. True it is that under the direction of Professor Mellanby and Mr. J. S. Brown, much work has been carried out for the British Marine Oil Engine Manufacturers' Association, and the results have been circulated among the members of that body, but work on this important subject needs to be more widely known. If the metallurgical records of some of our special cast iron foundries and of the few enterprising firms of shipowners who conduct their own research work were available, information might be given which should prevent further difficulty with cast iron parts. The meeting between designers and foundrymen which took place in Glasgow last year is a step in the right direction, and the investigations which the Cast Iron Research Association is promoting will certainly have useful results. On parallel lines, the question of thin steel castings ought also to be profitably discussed. The marine engineer is quite at home with crank shaft design and its problems, and any difficulties experienced may be traced rather to lubrication than design. The problems connected with the lubrication of the large marine oil engine are very important on account of the large quantities of oil to be handled in the course of the year, and any reduction in the amount used would soon be shown in reduced operating costs. Other questions concern the standardisation of Diesel engine oils for main engine, auxiliary and compressor use. In the marine oil engine we are very far from the dry crank case, which is now used in some two-cycle engines of the hot bulb type, and in large engines the question of loss caused by the dispersion of oil mist, calls for consideration. The comparatively high-speed oil engines used for driving electric generating sets aboard ship differ very little from similar engines used in land stations, and there appears to be no reason why silent and reliable running should not be obtained. Some consulting marine engineers seem to have a preference for engines of the cold-starting type, which in future are likely to compete strongly with the Diesel engine proper for auxiliary work. A wide field for such engines is provided by electrically propelled ships, ferries and dredgers, which are being employed with great success in America.

Enough has been said to show that in the case of the land type of engine, free exchange of opinions and the discussion of the difficulties met with, has largely done away with early troubles, whereas with regard to the marine type of engine much remains to be done. The Marine Oil Engine Trials Committee as a body has decided merely to place on record without comment the results of the various trials carried out, but we are glad to note from the recent discussion of the second report of that Committee before the Glasgow Branch of the Institution of Mechanical Engineers, that individual members and observers are doing something in the direction of removing existing discrepancies and trial difficulties, and in comparing the performances of different types of machinery tested. These trials may be valuable when completed, but what we should like to see is a freer circulation of information concerning the difficulties experienced in the running of ships. Such information would be of great interest and benefit to

the owners, the builders and the operating staffs of ships that are propelled by internal combustion engines.

The Locomotive Trials.

FEW people who visited the Palace of Engineering at Wembley will have forgotten the two great locomotives which stood almost side by side, hurling, as it were, defiance at each other, one vocally asserting that it was the most powerful engine in the kingdom, whilst the other was content to leave the judgment in the hands of the spectator. Rumour has it that when Sir Felix Pole beheld the two champions face to face he was filled with a desire to see them pitted against each other, and even then set about making arrangements for the tests, which began on Monday last, when one of Mr. Gresley's Pacific's, "Flying Fox," took the Riviera express to Plymouth, and engines of Mr. Collett's "Castle" class hauled the Flying Scotsman as far as Doncaster. To the general public the trials, which will come to an end to-morrow, are simply a test of rival locomotives, but to the engineer there is more than meets the eye. There are certain outstanding differences in the two engines which it is necessary to recall. The most notable of them are that the Great Western engine has four cylinders against three on the London and North-Eastern engine, that the boiler pressure of the former is 225 lb. and of the latter only 180 lb., and that the North-Eastern engine has a pair of trailing wheels whilst the Great Western has not. The Great Western engine is materially lighter than the North-Eastern engine, about eighty tons as against ninety-two, whilst with tenders the former turns the scale at 120 tons and the latter at nearly 149 tons. There is not much to choose in driving axle loads, but what advantage there is lies with Mr. Collett's engine, which registers a few hundredweights under the twenty tons of Mr. Gresley's engine. The cause of these differences is to be found in the boilers. The boilers of the "Castle" class, exclusive of smoke-box, are roughly 25ft. long, whilst the length of the boiler of the Great Northern engine is 28½ft. The grate area of the Great Northern engine is 44½ square feet, whilst that of the Great Western engine is only a little over 30 square feet. The relative evaporative heating surfaces are 2930 square feet and 2050 square feet.

Every locomotive is designed for its own road and its own conditions. It has been frequently said that it is the "locomotive *and* the road" which constitute the railway. Neither can be divorced from the other, and it is always doubtful if any safe deductions can be made from the working of engines on "foreign" lines for short periods. In the case under consideration there is one factor of outstanding significance. Mr. Collett's engine is designed to burn good Welsh coal; Mr. Gresley s to burn Yorkshire coal. In that fact we may see the origin of the great difference between the two boilers and particularly the contrast in the grate areas. Molesworth gives the calorific value of Welsh steam coal as 16,000, and that of Yorkshire coal as 13,700. Hence 10 or 15 per cent. more of the latter must be burnt for the same output fo steam, and therefore the grate area and the evaporative surface have to be bigger. Mr. Gresley has made these dimensions nearly 50 per cent. greater than Mr. Collett's. That is certainly more than sufficient to account for the difference in the calorific value of the coal, but he gains thereby the great advantage of easy steaming. It is clear, however, that Mr. Gresley's box will be too big for the Great Western coal, and probably Mr. Collett's box will be on the small size for the Great Northern coal. Thus, if the figures ever become available, we shall not be surprised to find that neither boiler was quite satisfactory on the "foreign" road. So far as the trials have gone they appear to indicate that both engines were quite capable of hauling their respective trains accurately to booked time—as one might expect—but it can hardly be expected that in the course of a few runs anything definite as to the relative merits of the large boiler, high-pressure, or four cylinders and three cylinders will be discovered. We have said that the engine and the road must be considered together. It is of almost equal importance that the drivers should know their roads intimately. In these trials they have had small opportunities of learning them, and we believe each engine carries an inspector to pilot the drivers. Now the Great Western is an easy road as far as Newton Abbot, but thence onwards to Plymouth it is full of curves and a complete knowledge of it is needed; the road to Doncaster presents, on the whole, less difficulties, and the "foreign" driver should sooner acquire knowledge of it. For this reason the trials would have been more instructive had they been carried out on a neutral road, let us say, for example, the Great Central to Sheffield. There is a story amongst locomotive engineers that years ago when a somewhat similar test was being made an inspector who was overloyal to his own company, advised the driver to check his engine on every down gradient, and only when a hill had to be climbed did he say, "Now let her have it!" Needless to say time was lost. Whilst nothing of that kind is to be expected in this instance, yet the fact that the roads are not perfectly known to the drivers and are not quite comparable, introduces an element of uncertainty into the records.

It is, we think, desirable to make it quite clear that the trials are not a test of speed; this is not a locomotive race, but a series of tests of the efficiencies of two types. Hence the attention that is given to the gain of a few seconds or a few minutes by one or other of the engines is to be deprecated. It is their business to run to schedule. Anything over and above that is neither here nor there. On alternate days the North-Eastern engine is taking the Cornish Riviera express to Plymouth and then back again. The down train starts at 498 tons with 14 vehicles, but slips two coaches at Taunton and two more at Westbury. The up train starts at 293 tons but picks up four coaches at Exeter, raising the weight to 434 tons. The run is 226½ miles. On the London and North-Eastern Railway the trains which are being worked by the Great Western engine on alternate days are the 10.10 a.m. from King s Cross to Grantham, and the 3.7 p.m. Grantham to King's Cross; the former weighing 453 tons, and the latter 457 tons; and on the other days the 1.30 p.m. King s Cross to Doncaster weighing 451 tons, and the 6.21 p.m. from Doncaster to King s Cross weighing 439 tons. So far as the results have gone they show that either engine is quite capable of doing the work of the other. The point of real interest lies in such things as coal consumption, ease of steaming, relative wear and tear, and so on. Such records as it is possible to secure are, of course, being taken, but we do not know that they will ever be published. The engineering profession will lose something of interest if the companies decide to keep the results to themselves, but we doubt that they will lose much of value, for each engine was designed for its own road, its own coal, its own service, and it is unlikely that either Mr. Collett or Mr. Gresley will find cause to change his design materially.

New Bridge over the Niagara.

A NEW double-track steel arch bridge has been built across the gorge of the Niagara River for the Michigan Central Railroad Company. It is to replace the old cantilever bridge of the same company, which was erected in 1883 and strengthened twenty-four years ago by the addition of a middle truss with tower posts and pedestals. The increase in the weight of rolling stock and train lengths has for an extended period, however, resulted in the cantilever bridge being overloaded, and it has long been evident that a new bridge was needed, as the cost of maintenance, coupled with the speed and load conditions, were factors not to be overlooked. The cantilever stands 300ft. upstream from the lower steel arch of the Canadian National Railways, and the new arch has been erected between the two bridges.

In type, the new bridge is of the spandrel-braced, two-hinged class, very rigid and of handsome appearance, as the bottom chord is a parabolic curve. The length of the centre span or arch is 640ft. from centre to centre of end pins. The bottom chord rises 105ft. above the normal level of the river, and the crown depth is 20ft. There are sixteen panels of 40ft. in the arch, and plate girder approach spans of 100ft. and 125ft. respectively connect with the cliffs on both sides of the river, the 125ft. approach span being on the New York side. On the New York side the approach is carried on concrete piers back over Whirlpool-street, which is to be widened at that point, and similar piers carry the approach over the River road on the Canadian side. In general appearance the great new arch is far more massive than any bridge heretofore erected at Niagara. It contains 7500 tons of steel, of which quantity 4800 tons enter into the arch, bracings and castings, while 1500 tons are in the approach girder spans, street spans and back stays, and 1250 tons are in the floor.

Normal bridge steel with a specified ultimate tensile strength of 56,000 lb. to 64,000 lb. per square inch. was used, the elastic limit being 33,000. The rivet steel is softer. The two arch trusses are spaced 30ft. apart and have a slight outward batter downward. As compared with other Niagara bridges, the floor construction is unusual in that the entire floor rests on the top chord, and is not a part of the arch proper. A line of longitudinal girders was placed over the two top chords, and transverse floor beams riveted at intervals between the girders, so that the deck stringers rest on the floor beams. Avoidance of the participation of the floor in the arch stresses was effected by keeping each main panel section of the floor independent of the next one, so that each forms an expansion section of itself. The stringers are a quartette of 15in. I-beams under each rail, and to them have been added edging and footway beams, covered with a steel deck plate, in which the road bed ballast was placed, after concrete and waterproofing had been applied.

As planned, the bridge was designed for Cooper's E 70 locomotive loading, while for the arch members a uniform load of 7000 lb. per linear foot, following a 110ft. length of 9000 lb. per foot of track, was used. These loadings are said to be higher than the standard of the New York Central lines for a bridge of this span. The transverse beam deck of the approach spans was proportioned for a load of 18,000 lb. per foot of track over a 10ft. width, the longitudinal deck of the main span being proportioned for the E 70 loading direct.

Work on the foundation of the abutments was commenced in June, 1923. These abutments, or skewbacks, are four in number, two on each side of the river. A very careful study of gorge conditions was made preparatory to starting the bridge work. At first it was suggested to erect the proposed new arch under and around the present cantilever, but investigation of the slope of the gorge showed that the span would not be quite so great if the new structure were to be erected a short distance downstream, so the new site was selected. At the Canadian end the new bridge stands close to the cantilever, but in crossing the river, the structure diverges to the north. The abutments rest on the Clinton limestone, midway between the water's edge and the top of the cliff. This limestone ledge was covered deeply by a talus slope, and it was necessary to remove the *débris* to reach the Clinton ledge. On the New York side a chute and staging were used to protect the Gorge road cars and to carry the excavated material over the tracks, which at that point run very close to the water's edge. The rock excavated was dumped into the river and served to build out beyond the Gorge railway lines at a point where the rushing river was dangerously near the road. The excavations completed, the concrete work on the abutments went forward rapidly, so that the granite copings were set in December, 1923. Owing to the rock conditions, the abutments differ in size. At the skewbacks of the bridge of the Canadian National Railways, close by, a circular roller bearing is used, but for the new arch a pin hinge was adopted. The pin transfers the load to a cast steel shoe, which has a base of 14ft. by 14ft. 8½in. This shoe is in three pieces, right and left halves, and the top or pin section in a single piece. The pin is 19in. in diameter, and is not seated in the chord steel, but in a cast steel pin casting which receives the end of the chord. The maximum thrust through the shoe to the abutment is 11,150,000 lb.

The erection of the steel work was begun very early in the spring of 1924, and a feature unused in connection with any other arch erected at Niagara was that each half of the arch was built out as a cantilever held by an eye-bar tie running back about 105ft. in an anchorage tunnel in the side of the cliff at the upper part. A good deal of water was met with in the inclined anchorage tunnels and pumps were necessary to overcome its flow.

Except for the pin connections in the four short web posts in the middle section of the arch, and the pins which form the skewback hinges, all connections on the new arch are riveted. The bottom chord was designed as a box-shaped member, composed of two I-shaped ribs and top and bottom cover plates, the depth being uniform throughout. It is very heavy, and reaches a maximum cross section of 714.8 square inches in the end section, which is a 70-ton erection piece. The top chord, which is of normal top chord section, comprises two channel-shaped side members, with cover plates. The posts have channel-shaped side members connected by a continuous longitudinal diaphragm, the diagonals being of similar section without a diaphragm. All the members have stiff lacing on the open sides.

The new arch is the fourteenth bridge erected across the Niagara gorge, but of that number only four will be standing after the cantilever is razed. When that work is completed, there will be three steel arches and one suspension bridge spanning the Niagara gorge, the suspension bridge being at Lewiston, 7 miles downstream, where it is a link in the belt line tramway service. The new arch, which is the heaviest yet built at Niagara, was formally opened to traffic on Monday, February 16th last. Immediately thereafter, the work of taking the cantilever down was commenced, and that notable work will be completed during the approaching summer season.

BY the end of the year new escalators will be operating at the following London Underground stations:—Old-street (two), Oval (two), Clapham-road (two), Oxford-circus, Central London Railway (two), Tottenham Court-road (five), Bond-street (two), and Liverpool-street (one additional). All these escalators, with the exception of four out of the five at Tottenham Court-road, will be of the Cleat-comb pattern.

Literature.

Purchasing: Its Economic Aspects and Proper Methods. By H. B. TWYFORD. London: Constable and Co., Ltd. 1925. Price 21s. net.

WHILE much attention has rightly been devoted in recent years to the important question of accurate cost accounting, not nearly the same consideration has been given to the subject of purchasing, although the author of the present work correctly affirms that "it is easily conceivable that promiscuous buying would be a serious handicap to the success of any concern." By means of a diagram, giving a typical distribution of the charges that go to build up the complete cost of the finished article, with 32 per cent. allocated to raw material, 19 per cent. to direct labour, 22 per cent. to indirect expense, and the remainder absorbed in selling expenses and profit, Mr. Twyford contends that a serious investigation of the 32 per cent. is warranted, while we are also reminded that a fair amount of the 22 per cent. will be affected by judicious purchase, as it must necessarily include such items as factory expense stores, tools, and machinery. Obviously, the percentages will vary according to the nature of the product, but we see no reason to cavil at those given as a fair average. Having made his case for the desirability of investigation, the author proceeds to reduce the art of buying to an exact science, and is successful in so doing.

The book is divided into four main sections, dealing respectively with (1) the general principles of purchase, (2) the necessary organisation, (3) the operation of the purchasing department, and (4) practice, in which a chapter is wisely devoted to the small concern.

Emphasis is laid on the necessity for the whole onus of responsibility being vested in the accredited purchasing agent, thereby frequently saving the requisitioning of entirely unnecessary and useless material. We agree, but should like to have been told who is considered by the author to be the best type of man to be entrusted with the control of a large buying organisation, and would suggest that in an engineering works an engineer should be the one appointed. He would be able more readily to secure the co-operation of the heads of departments, and Mr. Twyford says "greatly increased efficiency can be obtained by effective team work," for the staff will not feel that they are dealing with paper and accounts, but rather with men and things.

The main branches of the organisation which are advocated are:—(*a*) The collection and recording of information; (*b*) purchases, including requisition, quotation and placing orders; and (*c*) invoices. In some concerns, in addition, traffic, inspection and stores come under the same administration, but we consider that, though admittedly ancillary, they should be regarded as quite distinct functions.

An open mind is shown on the question of the best method of procedure. We are told that the number of office forms should be reduced to a minimum, and that it is necessary to design and lay out one's own system to suit the requirements of the individual concern. Having said this, the author outlines a very workable scheme, which could safely be taken as the framework to which to apply modifications to suit any organisation. He is very insistent on the necessity for harmony between different sections, and is careful to link up his organisation with that of other departments in the business. As an example, the bill of materials, which must originate from the drawing-office, but is made by the purchasing department the basis of issue to the factory, is so used that more material cannot be obtained for an order in excess of that allowed on the bill, without high authority being invoked. When describing the recording of stock held, the author provides a card showing the maximum and minimum to be held by the stores department, and shows how he proposes to replenish it as the minimum is being approached. We would go a stage further, and have three columns—maximum, minimum, and *ordering level*—the last being determined in the light of previous experience, and to ensure that when the new goods arrive the minimum would barely have been reached. In some factories this plan has saved much disappointment.

Of special interest is a chapter devoted exclusively to the legal aspect of purchase, a careful perusal of which may save much of the trouble which is caused by laxity in making a contract, and may obviate the pitfalls incident to a change of contract, which should only be treated as an entirely new contract. Points of law in connection with "liquidated damages" are touched upon, and it may not generally be known that "a buyer may refuse to accept goods delivered prior to a specified date, and his refusal does not release the seller from his obligation to re-deliver the goods at the time and place specified." Most of us, however, suffer far more from late than from early deliveries!

The treatise under review is well arranged, suggestive, and admirably illustrated with 132 diagrams and sample forms, and he would be a dullard indeed who could not set to work to evolve a new purchasing department, provided he had this book beside him for inspiration, coupled with personal knowledge of his own particular needs.

We unhesitatingly commend Mr. Twyford's new work to the manufacturer who would be up to date, partly because it "satisfies a long felt want" for a standard book on a subject on which there is very little literature extant, and partly on account of the broad-minded manner in which the problem is handled, as well as the succinct way in which the author's conclusions are presented to his readers.

Truly, there is food for thought in the statement that "the problem of spending money judiciously and to good purpose is a harder and more difficult task than the acquisition of it."

The Transactions of the First World Power Conference. London: Percy Lund, Humphries and Co., Ltd. 1925. Four Volumes. Price £12 net.

THE publication of the full "proceedings" of the World's Power Conference, which was held at Wembley last year, is an event of some importance in the engineering world. Whatever adverse views may be held about the desirability of presenting several hundred papers at a conference extending over no more than a few days, there can be no question about the convenience of having in a collected form such a mass of information about the power resources of the world and their utilisation. The four volumes are of the familiar demi octavo size, and each contains some 1500 pages or more, as well as many plates. Although the subjects are subdivided by the volumes themselves, thus in a measure facilitating reference, and although each volume is provided with a table of contents, it is obvious that a search for any particular subject in such a great number of pages would be a difficult matter. We are, therefore, glad to learn that it has been decided to publish a complete index. Its price will be two pounds, and we understand that it will be ready for issue in a couple of months or so.

The first volume covers the papers and discussions on the "Power Resources of the World, Available and Utilised"; the second, "Water Power Production; Preparation of Fuels, and Steam Power Production"; the third, "Internal Combustion Engines, Gas and Fuel, Power from other Sources, Power Transmission and Distribution, Standardisation and Research and Illumination"; the fourth, "Power in Industry and Domestic Use, Power in Electrochemistry and Electro-metallurgy, Power for Transport, Economic Aspects of Power Resources and Education, Health and Publicity." We learn from the publishers that each volume can be purchased separately at £3 10s. apiece, which will, no doubt, be convenient to many people who are only interested in a special section of the work of the conference.

So much has already been said about the papers themselves that no remarks upon them are necessary. They are reproduced in these volumes in their original form with the useful *résumés* which accompanied them when they first appeared. When we turn to a consideration of the "Discussions," we are struck by their poverty. Out of the fifteen hundred pages or so of the first volume only seven are required for the discussions, and most of the speeches are no more than introductory remarks made by those who presented papers. In Volume II. we find four pages devoted to the discussion of a group of papers on Water Power Production, about twelve pages in all to the Preparation of Fuels, about eighteen to Steam Generation, and about eight to Steam Utilisation. In Volume III. some eight pages of discussion are given to Internal Combustion Engines, the same number to Gas and Fuel, seven to Power from other Sources, about ten, with several diagrams, to Power Transmission and Distribution, the same number to Power Stations and Transmission Lines—a long section—eleven to Distribution Cables, nine to Research—a very short section—two to Standardisation, and six and a-half to Illumination. In Volume IV. Power in Industry occupies over 500 pages, but the discussion takes no more than eight, four to to Power in Domestic Use and Agriculture, some five to Power in Electro-metallurgy, and six to Road and Air Transport. Power for Rail Transport is better served, in all its discussion occupies over sixteen pages, whilst Power for Water Transport requires only six. The discussions on the remaining papers in this volume, which run to over 1800 pages, fill thirty pages. In a very general way it may be said that, as one might expect, the length of discussion varied inversely as the number of papers on any one subject, which, plainly, is not quite as it ought to be, but is the inevitable result of having too many contributions for the time available. The quality of the reporting is a little variable, but, on the whole, it is well done.

As a source of reference these Transactions of the First World Power Conference must take an important position on the bookshelves of the engineer and the economist. They contain a mass of information, from all over the world, which it is not easy to collect from the diverse literature of the many subjects covered. But in the absence of a good index there is no "Open Sesame" to this wealth of knowledge, and we heartily applaud the decision to produce that index at an early date.

Hull Down: Reminiscences of Windjammers, Troops and Travellers. By Sir BERTRAM HAYES, K.C.M.G., D.S.O. London: Cassell. Price 10s. 6d. net.

REMINISCENCES of a sea-faring life from the pen of one who knows the sea as his right hand, and loves a good ship—such is Sir Bertram Hayes' book, and it is sure to appeal to a nation whose interest, whose very existence, lies in the broad highways of ocean.

Over forty-four years of sea life place the author in a position to speak with some authority on the merchant service, and he puts forward very frankly opinions on such subjects as docking and wireless aids to navigation, that are well worthy of consideration. In both of the matters named we are far behind other nations, and in the case of the latter behind even our own Colonies. We have only two or three wireless direction stations round our shores, whilst Canada, the United States and France are placing two or even three to cover the entrance to each port. In the matter of dry-docking, it is enough to point out that up to the present our largest ship, the Majestic, has had to be sent to Boston, Mass., to undergo her British Board of Trade survey, owing to the lack of a British dock capable of accommodating her.

On the direction and supervision of transport the author speaks with the experience of a troop ship commander throughout both the South African War and the greater, and more recent, conflict. Whilst expressing his high opinion of the Royal Navy at its own particular occupation, he does not admit that it can do the work of the merchant service better than that service can do it itself. He suggests that the supervision of transport in time of war should be undertaken by officers of the merchant service, instead of by retired naval officers who are often entirely unacquainted with merchant ships. In support of this view he tells an amusing story. Some motor cars had to be shipped, and the fore holds of the vessel in which they were to be carried were already full of cargo. The transport officer looked down the after hold. "Take that thing out and there will be plenty of room," he ordered. "That thing" turned out to be the tunnel through which the propeller shaft passed!

A great deal of progress has been made in the last forty-five years, and it is interesting to follow the development of shipping through the story of Sir Bertram Hayes' career at sea, from his apprenticeship in a "windjammer," feeding on "salt horse" and "Liverpool pantilles," to the command of the Majestic, the largest ship afloat; his early days in steam, when it was no uncommon occurrence for the steering gear to break down and for the after wheelhouse to get flooded; his recollections of troop ships in which he catches the spirit of Tommy Atkins to perfection, even to his love for sentimental songs, the gloomier the better; the ramming of U 103 by the Olympic—the "Old Reliable" as she had come to be called—which added the D.S.O. to his honours; and the taking over of the German Bismarck to become the Majestic of the White Star Line. All these memories are full of interest, and there is throughout the book a wealth of anecdotes, interesting and amusing, which never tire.

BOOKS RECEIVED.

The London Fire Brigade. London: Hodder and Stoughton, Ltd., 17, Warwick-square, E.C. 4. Price 6d. net.

The Rigid Airship. By E. H. Lewitt. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 30s. net.

Directory of Paper Makers of the United Kingdom, 1925. London: Marchant, Singer and Co., 47, St. Mary-axe, E.C. 3. Price 5s. 6d. net.

The Metalworkers' Practical Calculator. By J. Matheson. London: Sir Isaac Pitman and Sons, Parker-street, Kingsway, W.C. 2. Price 2s. net.

Report on the Railway System of Nigeria. By F. D. Hammond. London: The Crown Agents for the Colonies, 4, Millbank, S.W. 1. Price 5s. net.

La Relativité Dégagée a'Hypothèses Métaphysiques. By H. Varcollier. Paris: Gauthier-Villars et Cie, Quai des Grands-Augustins, 55. Price 50 fr. net.

The Colliery Year Book and Coal Trades' Directory, 1925. London: The Louis Cassier Company, Ltd., 34, Bedford-street, W.C. 2. Price £1 1s. net.

Low-temperature Distillation. By S. H. North and J. B. Garbe. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 15s. net.

Molybdenum, Cerium and Related Alloy Steels. By H. W. Gillett and E. L. Mack. New York: The Chemical Catalog Company, Inc., 19, East 24th-street, U.S.A.

Diesel and Oil Engineering Handbook; Land and Marine. Third edition. By Julius Rosbloom. London: Crosby Lockwood and Son, Stationers' Hall-court, Ludgate-hill, E.C. 4. Price 25s. net.

Screw Propellers. Third Edition. Vol. I. text and Vol. II. Atlas. By Charles W. Dyson. London: The Simmons-Boardman Publishing Company, 34, Victoria-street, S.W. 1. Price 67s. 6d. net the two volumes.

Annual Reports of the Society of Chemical Industry on the Progress of Applied Chemistry. Vol. IX. 1924. London: The Society of Chemical Industry, 46–47, Finsbury-square, E.C. 2. Price 12s. 6d. net to non-members and 7s. 6d. to members.

Comparison of Chemical and Bacteriological Examinations made on the Illinois River During a Season of Low and a Season of High Water, 1923–1924. By R. E. Greenfield; and a *Preliminary Notice of a Survey of the Sources of Pollution of the Streams of Illinois.* By G. A. Weinold, R. E. Greenfield and A. M. Buswell. Being Bulletin No. 20 of the Division of the State Water Supply of the State of Illinois Department of Registration and Education. Urbana, Illinois, 1925.

Propeller-jet Marine Propulsion.

WE have, for several years past, been following the course of a series of experiments in connection with the propulsion of boats, which has been carried out by Mr. Edmund S. G. Rees, of the Rees Roturbo Manufacturing Company, Ltd., of Wolverhampton. The investigations have now reached such a stage that an arrangement, devised by Mr. Rees, has been applied to three craft of widely differing character and size, and the company claims that sufficient experience has now been gained to place it in a position of being able to supply equipments constructed in accordance with Mr. Rees's discoveries.

In discussing this new system of marine propulsion, which, we are informed, is fully covered by patents, it may be explained at the outset that the problem which Mr. Rees set himself to solve was :—" Can the good features of propeller propulsion, jet propulsion, and twin reversing rudders be combined in one apparatus, and, if so, can the efficiency of the propeller be increased by that apparatus so that the speed of the boat will not be reduced by the modification ? " Mr. Rees claims that he has arrived at a satisfactory solution.

Before beginning his investigations some seven years ago Mr. Rees had made himself conversant with the work of previous experimenters in the same field. He was acquainted with the tests made by the Admiralty on the Waterwitch in 1866, and with the patents of Thornycroft (1879), Cloud (1904), Wadagaki (1906), and Rigg (1906), and he set himself to ascertain why none of the suggestions to direct the " slip stream " or " speed energy " running to waste behind the propeller into an expanding channel or tube had, judging by the fact that they had had no commercial development, come to anything. As a pump designer, and bearing in mind the great development in efficiency in centrifugal pumps which had taken place since designers' attention had been concentrated on diffuser channels round the impellers, he felt confident that the propulsion problem was capable of a similar solution. The first experiments were made with a small river boat, which was fitted with an expanding draught tube and a pair of balanced rudders, the latter being controlled by cords and springs so that the stresses and strains under running conditions could be observed, the springs being arranged to keep the rudders " fully open " when in the position for " full speed ahead." The boat was fitted before modification with a 3½ horse-power engine designed to run at 650 revolutions per minute, and a 14in. propeller which was capable of propelling the craft at a speed of 5½ miles per hour. With this small vessel a very large number of experiments were carried out on the river Severn in the summers 1919 to 1922.

On coming to test the converted craft he found, as was to be anticipated, that, in order to absorb the power of the engine and to propel the boat at the same speed as that at which it had travelled before conversion, the speed of the engine automatically increased. Mr. Rees explains that the theory of a draught tube, or diffuser, behind a propeller shows that the speed of the water discharged from the tube must be equal to the speed of the water through the equivalent propeller without a draught tube, in order to attain the same hydraulic efficiency. Consequently a draught tube has the effect of speeding up the propeller, or the pitch must be increased if the speed is kept constant. This is due to the extra speed of water induced in the neck or contracted portion of the draught tube. For the draught tube to operate properly, it was also found that the position of the propeller, with relation to the tube, was of considerable importance, and that the best position was immediately forward of the most contracted portion, which should be smaller in diameter than the outside diameter of the propeller so that the tube may fit the contracting jet issuing from the propeller.

By successive stages the diameter of the propeller was decreased from the original 14in. to 9in., and the pitch increased so as to keep the speed of the engine within reasonable limits, and it was found that the results obtained were unaccountably irregular. The same speeds of engine and boat could not always be obtained under what were apparently identical conditions. Seeking for the cause, Mr. Rees one day observed that, in the " full ahead " position of the tiller, the twin rudders, instead of being wide open, were partly closed against the springs, which indicated cavitation, and a greater pressure on the outsides of the twin rudders than on the inside, in spite of the stream of water from the propeller. The springs were adjusted so as to keep the rudders fully open, and the result, contrary to expectation, was to reduce the speed of the boat, with the same power, and that led to the conclusions that (*a*) the stream of water flowing through a simple diffuser, which expanded continuously from the throat to the discharge, was, when the diffuser was fitted to a moving vessel, in a state of unstable equilibrium, which prevented the diffuser operating properly, and (*b*) that, although the aim had been to make a true pump by combining an impeller—the propeller—with a diffuser, that object had not been achieved because the jet was not discharged from a chamber containing a greater internal pressure than the surrounding water.

Acting on this idea, and bearing in mind what he did when developing the Roturbo pump, which was based on a revolving pressure chamber, Mr. Rees then added to his draught tube a sealing bulb or pressure chamber of greater cross sectional area than the discharge orifice, in order that the pressure of the fluid stream might be raised to a greater value than that of the surrounding fluid. This simple modification was accomplished by designing a tube of greater expansion ratio than was required and contracting the discharge end into the necessary area to give the ultimate expansion ratio desired. The diagram—Fig. 1—shows what, in effect, was done. The dotted line indicates a simple or uniformly expanding tube or diffuser as originally tried, and the full line the modified diffuser with " pressure water " in the enlarged position about P. When this device was adopted all uncertainty of operation disappeared. In practice, when the manœuvring qualities of twin rudders are required, the twin balanced rudders are made movable parts of the enlarged or sealing bulb, and it is claimed that all the manœuvring and reversing qualities possessed by jet propulsion fed by a centrifugal pump placed inside the boat have been secured without detriment to the efficiency of propulsion, as compared with modern practice, and without excessive stresses on the deflecting pallets. It is further claimed that, as an additional result of the arrangement, a condition has been created in which the pitch and speed of the propeller are not dependent on the speed of the vessel, but can be varied, within certain limits by varying the ratio of expansion of the diffuser, as one varies the ratio of gearing when used to couple up two different speeds required for engine and propeller, which speeds are becoming more widely separated with modern high-speed marine engine practice.

Having satisfied himself regarding the performances of this small river boat, Mr. Rees next fitted his device to a larger boat, which is capable of going out to sea and is equipped with a 35 horse-power engine that gives it a speed of 8½ knots. The craft performed well after conversion, and the device acted in every way as it had been anticipated that it would. Finally, the device, modified as the result of the experience gained with the two preceding equipments and designed to meet the special conditions required, was fitted to a canal barge, 72ft. long, capable of carrying 25 tons of cargo and intended for a speed of 3 miles per

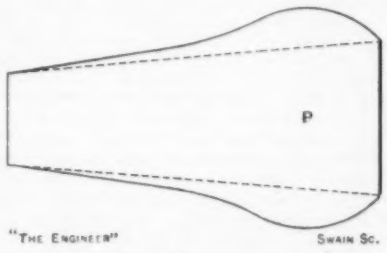


FIG. 1

hour. We have had an opportunity of examining this craft carefully and of making a voyage in her, and as the equipment with which she is fitted embodies the latest developments we propose to describe it in what follows.

The propelling device is illustrated in Fig. 2, which gives three views of the apparatus before it was fitted to the boat. It will be observed that the propeller is arranged in front of the throat of a tube, which is flared at its forward end and is actually slightly tapered, though that is not very apparent in the engravings, and the aft end of which opens into the bulb-shaped twin rudders, the space enclosed between which is of greater cross section than that of the fixed part of the tube. The bulb-shaped rudders are carried in bearings in an upper and lower horizontal plate, which plates are extensions of the fixed expansion tube. These vanes or rudders are operated by a compound tiller —the general mechanism of which is old for twin rudders, see Lund's patent of 1909—in such a way that (1) the aft discharge orifice may be altered in area from " fully open " to " fully closed," the vessel in the former case being propelled ahead and in the latter case astern in a line parallel with the keel, and (2) the discharge may be deflected to one side or to the other so that the vessel may be steered.

The gist of the apparatus lies, as already explained, in the position of the propeller in the throat of the tube and in the fact that, at the rear of the tube and just forward of the discharge orifice, there is what Mr. Rees terms a pressure chamber, which is larger in cross section than the discharge orifice. By the addition of this expansion chamber Mr. Rees claims to have not only overcome the defects inherent in a draught tube when used with a propeller alone, but also to have increased the efficiency of the combination of a propeller with a draught tube—a combination suggested and tried, apparently without success, many years ago—by a very considerable amount.

The gear by which the hemispherical vanes are manipulated and steering is effected is illustrated in Fig. 3. Although, as explained above, this apparatus is not new in general principles, it possesses several novel features which have been devised to meet the special requirements of Mr. Rees' invention. It consists of a tiller which swings on a post or pivot A and is furnished at its forward or inboard end with a hand wheel B. By revolving B in one direction or the other the rod C is moved forward or aft in consequence of the rotation in one direction or the other of the nut C^1 which works on the screw thread D cut on it. The rod C—the aft end of which, it will be observed, works in a guide cylinder L which is furnished at its aft end with a vent hole for the release of the air which would otherwise be compressed when the rod is forced into it—is pierced by a slot in which the cross piece E is rigidly secured by a pin. To the ends of this cross piece are pivotally connected the forward ends of the coupling rods F and F^1. The aft end of the coupling rod F is connected through the crank arm G—which pivots on the post A—the link H and the crank arm J with the spindle K by means of which one of the adjustable hemispherical vanes controlling the discharge orifice is actuated, the crank arm J being, of course, rigidly connected to the spindle K. Similarly, the aft end of the coupling rod F^1 is connected through the crank arm G^1—which, like G, pivots on the post A—the link H^1 and the crank arm J^1 with the spindle K^1 by means of which the other adjustable vane of the discharge orifice is controlled. The two sets of rods, links and cranks are identical. The length of the screw D on the rod C is such that the rotation of the hand wheel B can bring about the entire range of orifice opening, from " fully open " aft for ahead working, to " entirely closed " aft for going astern, the forward edges of the hemispherical vanes being in the latter case withdrawn from the sides of the expansion chamber, so that the water forced into the tube and expansion chamber by the propeller has to escape in a forward direction between the forward edges of the vanes and the pressure chamber, thus tending to propel the vessel astern.

Steering is effected by moving the tiller to port or to starboard by means of the handles M and M^1, the result being that the direction of the discharge jet is altered correspondingly with the degree of throw-over of the tiller. The effect on the vessel of moving the tiller either to one side or the other is exactly the same as if the boat were being steered by an ordinary tiller and rudder, namely, if the tiller be put to port the vessel tends to head to starboard and *vice versâ*. Moving the tiller, say, to port has the effect of revolving both the hemisperical vanes in the same direction, that on the port side being made to move towards the axis of the boat, while the starboard vane is moved away from the axis. In this way the direction of flow of the discharge is diverted by the port vane to starboard and the vessel tends to head to starboard. As long as the discharge orifice is not fully open there is free movement of both vanes up to the point when the forward edge of the vane being moved away from the axis—in the case we have taken, the starboard vane—comes up against the side of the expansion chamber. It is obvious that, unless some special provision were made to permit of it, there could then be no further movement of either vane, since the two systems of rods, links and levers are locked together. The way in which it is made possible to move still further the vane which is not abutting against the expansion chamber—in the case under consideration the port vane—is by making the connecting-rods F and F^1 telescopic, though by reason of the springs and plungers inside them they always tend to return to their shortest length. It is obvious that if the thrust be on the rod F, and if the starboard vane be prevented from further move-

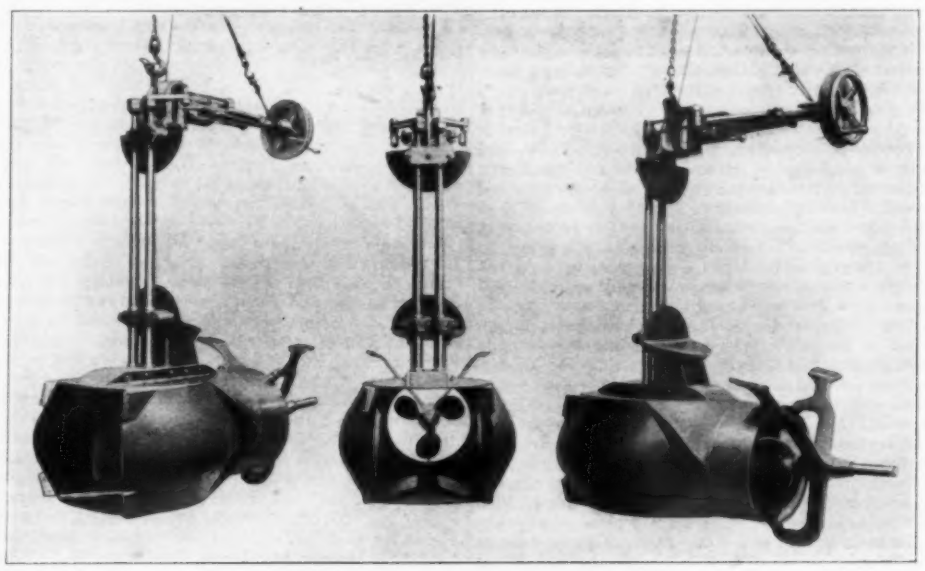


FIG. 2—THE REES PROPELLER-JET PROPULSION DEVICE

ment, then further thrust on F will cause the rod F^1 to lengthen against the action of its spring. On the tiller being returned to the central position, the rod F^1 will be brought back to its original length. In like manner, under similar conditions, the rod F will be lengthened if the tiller be pushed to starboard. It will be evident that, if the discharge orifice be fully open, the movement of the tiller to one side or the other must cause either the rod F or the rod F^1 to lengthen, since the forward edges of both vanes will then be in contact with the sides of the compression chamber.

The canal barge to which the device is fitted is, as has been said, 72ft. long, and it is 7ft. wide. Canal barges are unwieldy craft, and, because of their slow speed, they are generally very sluggish in answering the helm. During our trip on her we had an opportunity of observing the fitted barge under service conditions, fully loaded with coal, on a canal running out of Wolverhampton. The speed of 3 miles per hour was well maintained, and throughout the run everything worked smoothly, the operations of starting, stopping and steering being performed with apparent ease. There were numerous occasions on which quick manœuvring was called for, as the canal was crowded with traffic, and laden barges kept continually turning into it from side branches, but the boat readily answered her

helm, and once, what would otherwise have been a collision, was averted by the prompt closing of the two vanes together, thus closing the aft discharge orifice and causing the discharge to be made in a forward direction so that the boat was speedily brought to a standstill. Half way through our trip the barge was turned round, for the return journey, in a basin only just large enough for the purpose, the process being effected by means of the propeller and "device" alone. With regard to the question of the ease or otherwise of steering we may say that, though we did not attempt it ourselves, it would seem not to be difficult to learn, for we gather that, since our inspection, the barge, when carrying a full load of slack,

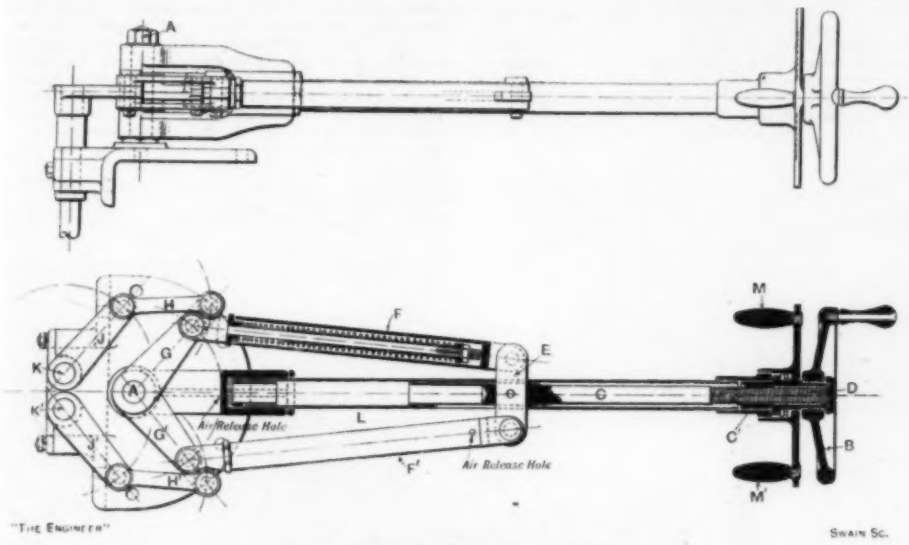


FIG. 3—ARRANGEMENT OF THE TILLER

was perfectly handled over a journey of several miles by a barge-man at his first attempt and without any previous practice. It will, of course, have been understood from the foregoing that the barge has no other rudder than the "device." It may be added that the fitted barge is furnished with a 16in. propeller with a 17in. pitch, which, for a speed of 3 miles per hour, runs at 700 revolutions per minute.

So as to give a better idea of the construction of Mr. Rees' propulsive equipment than is afforded by Fig. 2, we reproduce in Fig. 4 a drawing of an apparatus designed for a propeller 17in. in diameter and with a ratio of expansion in the draught tube of 3 to 1, the throat diameter

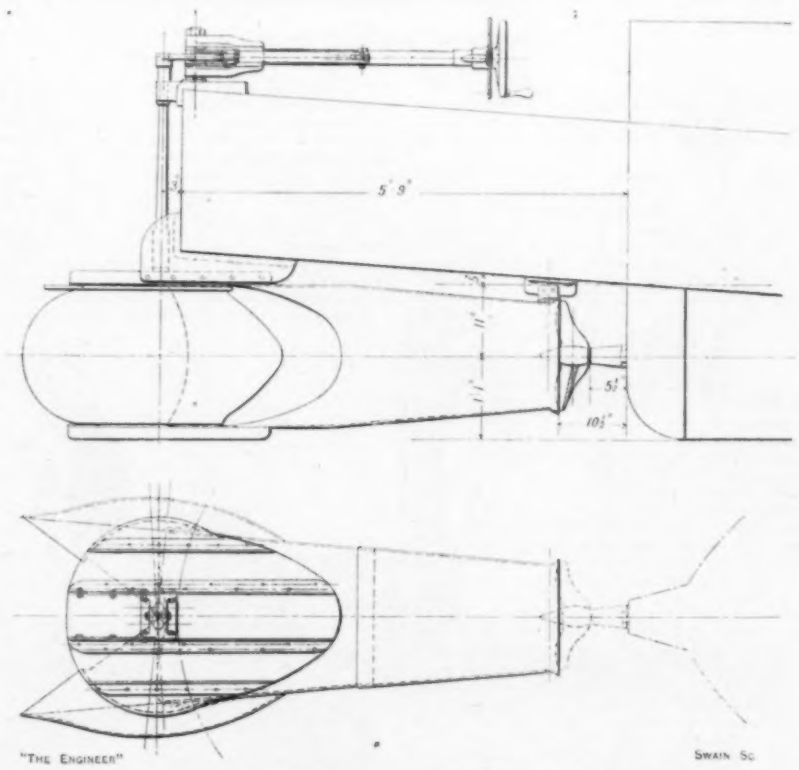


FIG. 4—THE DEVICE AS APPLIED TO A PROPELLER 17in. IN DIAMETER

being 16in. The drawing speaks for itself and requires no explanation. It may be pointed out, however, that the area of the discharge orifice is the same as that which the draught tube would have had, had it been prolonged so as to form the orifice without the intervention of the expansion chamber. It may be explained, too, that the ratio of expansion in the draught tube of the apparatus fitted to the barge is 2.2 to 1.

In considering, generally, the operation of the apparatus, it may be pointed out that it can be shown, mathematically, that, theoretically, the addition of a correctly designed and proportioned draught tube should effect a reduction in the power required to propel a given vessel at a given speed. It is also necessary, with a tube, to run the propeller faster or to increase the pitch—because of the greater volume of water induced through the propeller by the draught tube—in order that the same results as before may be obtained. There are, also, certain other conditions governing the arrangement, and its employment for a given speed has to be limited between two extremes, viz. :—

(*a*) Making the *inlet* area of the tube the same as the area swept by the original propeller, in which case there is economy in power ; and

(*b*) Making the *exit* area of the tube the same as the area swept by the original propeller, and using a new propeller of reduced diameter at the smaller end of the tube, in which case the power remains the same. With regard to (*b*), Mr. Rees remarks that, with the conditions specified, a higher speed propeller can be used so as to be able to increase the speed of the driving apparatus, or in case of a gear drive, the gear ratio may be reduced. By working between the limits (*a*) and (*b*) he claims that both economy in power and increase in speed of the propeller can be obtained. It will be understood, of course, that the use of a draught tube allows of a propeller being run at higher speeds without the occurrence of cavitation.

It is obvious that the ratio of expansion practicable is limited by the vacuum induced in the neck of the draught tube, and as that vacuum is dependent on the relative speeds of the tube moving with the vessel, and the water driven through the tube, the higher the speed of the boat the less the expansion ratio which is possible, and, therefore, the shorter the tube. With slow-speed craft, such as a canal boat, a ratio of 3 or 4 to 1 is quite practicable, but in the higher speed vessels a ratio of 1½ to 1 is as much as is practicable, without inducing too high a vacuum behind the propeller.

Mr. Rees anticipates that, by the use of his device, it will be possible to do away with a certain amount of reduction gear. He argues that, if the effect of the draught tube is to increase the speed of a propeller when the engine speed remains the same, a direct drive can be attained, if the two speeds were, originally, not too far apart ; or a less ratio of gearing can be adopted which, before, would have been uneconomical. With regard to the limits in the size of vessels which can be fitted with the apparatus, Mr. Rees argues that there is no limit to the size of a centrifugal pump impeller which is benefited by the addition of properly designed diffusers, and that the same conditions should apply to propellers if they are forced up in speed by modern conditions, so that there is loss of power worth picking up in the slip stream.

Bombay Water Supply—Tansa Completion Works.

WE have on several previous occasions referred to the Tansa completion works, which are to provide an additional supply of water for Bombay. We are now enabled, by the courtesy of Mr. H. J. Trivess Smith, M. Inst. C.E. the special engineer to the undertaking, who has sent us two quarterly official reports, to give the following particulars as to the progress made with the work during last year.

Up till the end of September the quantities of the main items of work done were as follows :—

	Cubic feet.
Embankment built	32,500,000
General excavation	14,000,000
Excavation in hard rock	10,000,000
Rubble stone pitching to slopes	1,000,000
Lime concrete in foundations of culverts, &c.	1,280,000
Un-coursed rubble masonry in culverts, &c.	960,000

During the last three months of the year the following additional quantities of work were carried out :—

	Cubic feet.
Embankment built	1,500,000
Rock excavation	240,000
Rubble stone pitching to slopes	230,000
Lime concrete	20,000
Rubble masonry in culverts, &c.	46,000

These totals, it is to be noted, were reached in spite of the fact that general sickness—principally malaria, dysentery and pneumonia—among the supervising and labour staffs prevailed along the whole length of the pipe line throughout the three months.

It will be remembered that for this undertaking riveted steel pipes—principally 72in. in diameter—are being employed. The steel plates were made in England by Dorman, Long and Co., Ltd., in a specially erected factory, and were shipped out to Bombay, and conveyed to Mulund, where Messrs. Braithwaite and Co., the contractors, had also erected a special factory where the pipes are fabricated, and, for the most part, riveted. The fabricating factory was completed early in 1923, and the actual work of making the pipes was begun in July of that year, the first consignment, consisting of six pipes, being despatched from the factory on August 16th following. Riveting in the field was begun on August 21st.

The total lengths of 72in., 60in. and 57in. pipes which are to be laid are 425,600ft., 17,000ft., and 146,500ft. respectively, making a grand total of 589,100ft. Up to the end of last September a total of 228,988 lineal feet of 72in. pipes had been fabricated and transported to site, and of that total, 144,099 lineal feet had been riveted at site. During the three following months, an additional length of 59,022ft. of 72in. pipe had been fabricated and transported to site, and 73,729ft. had been riveted at site, so that at the end of the year a total of 288,010ft. had been fabricated and transported to site, and 217,828ft. had been riveted at site. At that period there remained to be fabricated a total of 137,590ft., and to be riveted at site 207,772ft., so that the work was more than half done.

It is interesting to note the monthly variations, not only in the quantity of pipe riveted at site, but also in the quantity fabricated. The smallest quantity fabricated in any one month in 1924 was 2598ft. in July, and the largest quantity 35,882ft. in March. The smallest total riveted at site in any one month was 3236ft. in September, and the largest 34,891ft. in December. No explanation is given in the reports as to the reasons for these considerable fluctuations, and the variations do not appear to follow the seasons of the year. We may say in passing, however, that following the 34,891ft. of December, over 56,000 lineal feet of 72in. pipes were transported over a distance of 30 miles and riveted up complete during January of this year. That is to say, practically 11 miles of 72in. pipes were made and laid in a month. Commenting on this achievement, Mr. Trivess Smith remarks :—"So far as I can ascertain, this seems to be a world's record. If not, considering it has to be accomplished with native labour, it is very good going." The work of riveting in the field was carried on from nine stations, at various points along the pipe lines.

The total weight of plates required for the work amounts to nearly 80,000 tons, and the whole of that quantity had been made and the last consignment despatched from England by the end of last September. The largest number of rivets driven in the shops in one working day of sixteen hours was 35,797, with twelve riveting machines. Altogether, the total length of 72in. pipe to be made and laid is 80½ miles, of 57in. pipes 28 miles, and of 60in. pipes 3 miles, making a total length of 111½ miles, approximately, of pipe line.

The work of building the Tansa new outlet well had made good progress towards completion by the end of September, when operations were, apparently, stopped for a time. The foundations of the enclosing wall had been put in, and about half the length brought up to full height. The new outlet pipes, to which the 72in. steel pipes were to be connected, had been built in, and temporary works carried out to maintain the supply of water to the city during the alterations to the original outlet works. A good deal of trouble from water was experienced in putting in the foundations. Work was resumed at the end of November. The masonry conduit between the north end of the outlet well and the Tansa aqueduct was completed and taken into use on December 16th, which enabled the old outlet well to be closed down, and the masonry of the outlet well beneath the aqueduct was then proceded with. It was anticipated that the new outlet well would be ready to be brought into use by April of this year.

Of the twenty-eight cylinders of the Kasheli South

Bridge, seventeen had been founded and four spans out of thirteen had been built and riveted at the end of September. The bridge is 1800ft. long and 60ft. wide, and the piers are of concrete, 14ft. in diameter. It conveys the pipe line across Bassein Creek. During the three months ending December 31st last, four piers, comprising eight cylinders, had been sunk, while six spans of the superstructure had been erected, and the 72in. pipes laid on them. At the end of the year seven spans still remained to be erected, and it is anticipated that the bridge will be completed and handed over some time during the coming June.

Kasheli North Bridge is to be 60ft. in width and will consist of ten spans of 43ft. each. It is being erected on concrete piers, hexagonal in section, and 12ft. in diameter. The first caisson was sunk on April 5th, 1923, and the last of the twenty-two in May, 1924, the concrete columns being completed up to high-water level by August 12th last year. An accident, the nature of which is not explained in the reports from which we are quoting, happened to the west column of No. 9 pier a few days later, and, in consequence, it was considered advisable to rebuild two piers—Nos. 9 and 10. This evidently delayed matters, but it was expected that the work would be completed by the end of last March. The erection of the steel joists of the Bandra Bridge was nearing completion at the end of the year.

A Century of Gas in South London.

"A CENTURY of Gas in South London" is the name applied to a booklet which has been prepared to commemorate the centenary of the foundation of the earliest of the several gas supply undertakings, which, amalgamated together, went to constitute what is now the South Metropolitan Gas Company. The first gasworks on the south bank of the river Thames in London were erected by a Scot, named Munro, in 1814. They were sold a few years later to the South London Gas Company, which, when in difficulties in 1824, parted with them, in turn, to an influential body of men who banded themselves together under the title of the Phœnix Gaslight and Coke Company. After many years of keen rivalry, the Phœnix Company became merged in the South Metropolitan Company, the operations of which are thus considered to date back one hundred years from 1924, though, as a matter of fact, it, itself, was not formed till five years later than its rival, namely in 1829.

The book tells the life history of a commercial business, which has always been excellently managed, though it has had its ups and its downs, and experienced its vicissitudes. Its first works were erected on 3 acres of land along the Grand Surrey Canal, on the eastern side of the Old Kent-road, in 1833. It and the Phœnix Company are described as competing in the sale of "a commodity whose nature, power and possibilities they only dimly understood. Even the idea of carrying gas in pipes came gradually, for some gas companies made up their gas in packets and sold it, as oxygen is now sold, compressed in cylinders. . . . The gas varied astonishingly in quality, and in the purchase of so mysterious a commodity the buyer found new and startling applications of the old adage *caveat emptor*. Let the buyer beware of being blown through a window or having his family asphyxiated in their beds! Gas heavy with impurities choked the pipes, and the plumbers and gasfitters of those early days became proverbial for their rascality."

The South Metropolitan Company, we are told, started operations with the good resolution of supplying the public with a pure article. To that end it built a purifying house, which is described as being a model of all that such a house ought not to be. "Its windows were glazed; there was practically no ventilation, and it is surprising that it lasted so long as 1836, when it was completely destroyed by an explosion." However, it weathered through that and many other similar teething troubles, and kept up a stern struggle with its great rival the Phœnix Company. It was not indeed until nearly half a century later, *i.e.*, on January 1st, 1880, that fusion between the two took place, though as early as 1853 a working agreement defining the spheres of activity of the two concerns, as well as that of the Surrey Consumers' Gas Company—a later competitor—had been come to, largely by the good offices of Mr. Thomas Livesey, who was secretary and manager to the South Metropolitan Company from 1839 to 1871.

The "South Metropolitan" has always been a progressive company, and the volume tells of the various steps which it took to "get out of the rut." The rule-of-thumb gasfitter was superseded, his place being taken by a trained staff under the company's control; then it established its own physical and chemical laboratories, and devised its own standard apparatus. After trying in vain to get a satisfactory burner from outside, "it applied its chemists and its physicists to the problem, designed its own burner, set up its own burner shop, manufactured its own gauges, and so got the article it wanted." The company, we read, went to work in the same spirit on the problems of heating and cooking, "and in the end made the gas oven and the gas fire indispensable to the housewife. As gas became more and more of a blessing and less and less of a nuisance, the women of South London became the friends and allies of the 'Metro.' Thus equipped, the company could face with equanimity its new foe in shining armour." Its "new foe," be it said, was electricity.

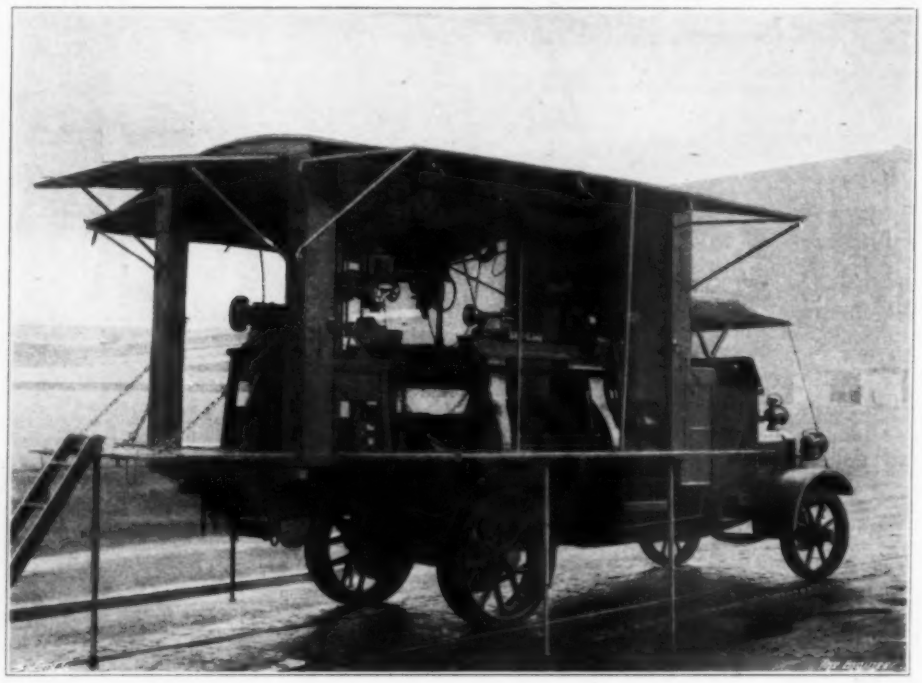
Then we are told of the labour troubles brought about by the activities of the Gas Workers' Union, which was founded in 1889. Of this crisis in the company's history and the way it was met by George Livesey, who had for many years been its secretary and engineer and who was then its chairman, there is no need for us to write here, but the book explains it and his world-famous profit-sharing scheme, which resulted in the fact that, since it was put into effect, the company has not experienced any serious industrial trouble.

To the general history of the undertaking as set out in the book we have no space to refer. Suffice it to say that the story is well written and interestingly told. The volume is well got up and is illustrated by reproductions of some excellent drawings, one of which even succeeds in hiding the ugliness of a gasometer! As an appendix are given portraits of various past and present officials of the company, including those of the celebrated Thomas Livesey and of his even more famous son Sir George T. Livesey.

A Motor Workshop Wagon.

THE engraving reproduced on this page illustrates one of several motor wagons fitted up as travelling workshops, which have been recently supplied to an overseas Government by the Albion Motor Car Company, Limited, of Scotstoun, Glasgow.

The chassis of the machine is the maker's standard 3-ton type fitted with a 32 horse-power petrol engine and has a floor space available for the workshop measuring 12ft. 6in. long by 6ft. 6in. wide. The sides of the body are, however, hinged so that the lower halves can be spread out on props to increase the floor area, while the upper halves form a canopy. The overall dimensions of the floor are then 16ft. by 13ft. 4in. The height from the ground to the platform is 4ft. 2½in. and the headroom under the roof at the sides is 6ft. 5in. The total weight of the vehicle is 6½ tons.



ALBION MOTOR WORKSHOP WAGON

All the machines are driven electrically, and for supplying the necessary current a 3½-kilowatt, 110-volt generator is fixed to the floor of the workshop. It is driven by a silent chain from the engine clutch shaft and its output is controlled by means of a shunt field regulator. The switch board, which is fitted on the forward bulkhead, includes separate switchgear for each unit of the equipment, together with appropriate fuses. A voltmeter and an ammeter are arranged in the dynamo circuit and there is a second ammeter for the accumulator charging circuit.

The principal item of the equipment is, of course, the lathe, which is of 6in. centres and is driven by a motor geared directly with the fly-wheel. There is also the usual treadle gear for use in case of emergency. The lathe is provided with a full equipment of chucks, face-plates, steadies, change wheels, &c. There is a small grinding machine, mounted on its own stand, which has two 10in. by 1in. wheels driven directly by an electric motor.

Two electric drills are provided. One is of the ordinary hand type, with a capacity up to $^{9}/_{16}$in., but it can be used in conjunction with a pillar on the bench when the work is convenient. The larger machine is capable of drilling holes up to 1¼in. in diameter and is fitted on a strong teak stool. It is a substantial machine and is capable of tackling quite heavy work. Both drills are provided with complete ranges of twist drills.

The smiths' hearth is blown by a little Roots' blower, and the smiths' tools are kept in a chest on the floor, while there are drawers under the fitters' bench for small tools, screwing gear, and so forth.

The lighting equipment, it will be seen, is extensive and comprises four hand inspection lamps and two three-light cargo clusters. The lamps are held in felt-lined clips screwed to the roof and can all be extended to points at considerable distances by means of extra wiring carried in coils on the forward partition.

An Electric Lighting System for Collieries.

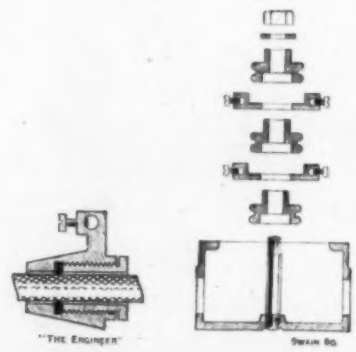
A COLLIERY electric lighting system has been designed by British Insulated and Helsby Cables, Limited, of Prescot, to meet the requirements of the latest Home Office regulations relating to lighting in mines. Cables are used that have proved to be suitable for use underground, and a special range of flame-proof and water-tight junction boxes and lanterns, with clamping and bonding glands for the Helsby twin-armoured cables, has been developed.

The round twin cables are insulated with pure and vulcanised rubber, and are constructed to withstand mechanical injury and the wet conditions generally prevailing in mines. The component parts of the junction boxes, which are made of iron, are interchangeable, and there are wide machine-faced joints between the body and cover which is secured in position by four bolts. All the exposed steel bolts, nuts and studs are standardised in order to prevent corrosion.

The cable glands are of the cone type, and the armouring of the cable is secured between a malleable iron clamp and the outer surface of the brass cone, which is bored to receive the core of the cable. The brass cone is seated into the box, a leather gasket being provided to make the joint water-tight. Each brass cone is provided with a bonding lug for the reception of a 7/.064in. copper earthing conductor. An alternative design of brass cone, as shown on the left of the accompanying illustration, is supplied for use when the boxes are filled with compound. The cone, it will be noted, is internally threaded for the reception of a brass bush and rubber packing ring, whilst the bush and cone are bored out to receive the core of the cable, and on tightening up the bush the packing ring is firmly compressed on to the cable core.

Connections inside the junction box are made by means of detachable brass connecting pieces, which are mounted on a central stud in the junction box, and are rigidly clamped between insulating bushes. Details of the arrangement are shown on the right of the accompanying illustration. In situations where inflammable gas is present or is likely to be present in sufficient quantity to be dangerous; the makers strongly recommend that the boxes should be filled with compound in order to secure the greatest degree of safety, and to enable this to be done the makers fit, when specified, compound filling plugs.

Each conductor of the Helsby twin-armoured colliery



CABLE GLAND AND JUNCTION BOX

lighting cables is composed of high conductivity tinned copper wires, which are insulated with pure and vulcanised rubber, and are lapped with a water-proof tape. Two such conductors are twisted together, wormed circular, taped with waterproof tape, served with impregnated jute yarn, armoured with a layer of galvanised steel wires, and are protected overall with a braiding or serving of jute yarn, thoroughly impregnated with waterproof compound.

A joint box designed for use in connection with the system is suitable for Helsby twin-armoured cables up to 7/.036in. It may be used as a terminal, straight through angle, or three or four-way box, provided the user specifies his requirements.

The box is provided with a plain machine-faced cover, but, if required, it may be drilled and tapped to take ¾in. conduit, and it can also be fitted with a filling plug when it is desired to fill the boxes with compound. Three stan-

dard lighting fittings are supplied, all suitable for Helsby twin-armoured colliery lighting cables up to 7/.036in. One of these fittings is a colliery lantern and box suitable for vacuum lamps with a consumption up to 60 watts, and consists of a well glass lantern which is attached to the metal box.

Thick rubber gaskets are inserted between the well glass and the metal work of the lantern, and the ring which holds the glass in position is secured by swing bolts and hexagon nuts. The bolts can be sealed by means of wire, and the nuts can only be removed with the aid of a special spanner. The guard wire which protects the glass, and which is very strong, can be removed for the purpose of cleaning the well glass without breaking the seals.

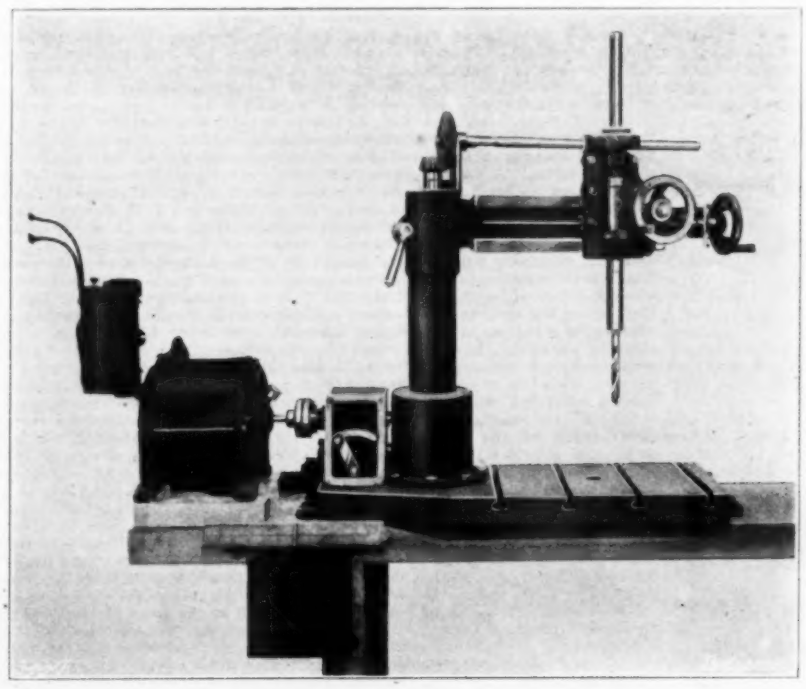
The second lighting fitting is a colliery bracket lantern box which is also suitable for vacuum lamps, with consumptions up to 60 watts. This fitting is designed so that the well glass is at right angles to the box instead of in line with it, as in the case of the fitting just described. The third standard lighting fitting is intended for gas lamps up to the 100-watt size, or for two 60-watt vacuum lamps. Large radiating fins on the top of the lantern serve for cooling the fitting, and tests have shown that with a 100-watt gas-filled lamp in the lantern the maximum temperature rise within the box is less than 40 deg. Fah.

A Miniature Radial Drilling Machine

THE interesting little radial drilling machine illustrated herewith has recently been completed by Mr. J. Wightman, 18, Park-lane, Sheffield, in his private workshop. The weight of the whole machine is but 1 cwt., it has an effective radius of 18in., and is driven by a ¼ horse-power single-phase slow-speed motor, through a flexible coupling and a two-speed gear-box. The column stands 2ft. high above the bed-plate.

Mr. Wightman holds that a sharp line should be drawn between a model and a miniature. The former, being to scale, has some of the parts weak, diminutive and totally unfitted for serious work, whilst a miniature is designed from the point of view that it is to be small and symmetrical, but capable of a considerable and serious output. The drilling machine illustrated, Mr. Wightman informs us, can easily take a 1in. twist drill, 3in. deep, through the solid in cast iron, or drive a 1¼in. drill the same depth through the same material following a small pilot hole. It will also bore with a cutter bar up to 2¼in. diameter. In preparing the design, the whole of the machining operations were kept within the capacity of a 4in. Britannia bench lathe and a 7in. stroke Firth hand shaping machine, with the exception of the planing of the bed and the arm, and of the gear cutting.

The drill speeds were made purposely low with a view to obtaining the greatest capacity in dealing with large holes. They are 43 revolutions per minute on the slow gear and 83 revolutions per minute on the fast. The first motion shaft of the two-speed gear-box carries phosphor-bronze spur pinions, working into red fibre spur rings, mounted on a cast iron centre, which slides on a feather key. The bevel bearing at the bottom and top of the main column is of 1 to 1½ and 1 to 2 ratio respectively, and the drill spindle is driven by spiral gearing of 16 to 39 ratio. The arm revolves completely round the column and the headstock is moved to and fro horizontally by means of a single-threaded screw of ⅛in. pitch. The feed is obtained



MINIATURE RADIAL DRILLING MACHINE

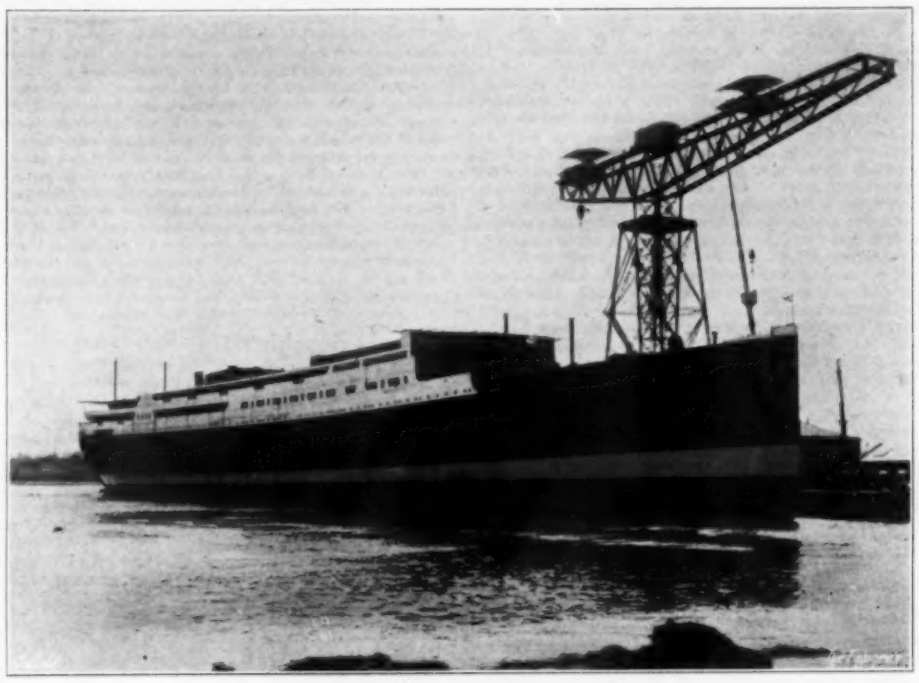
from a mild steel spur pinion working into a rack cut upon the circular quill, the pinion being driven by a bronze worm wheel of forty-eight teeth, gearing with a worm of six threads per inch, attached directly to the feed hand wheel. The single-phase, self-starting, ¼ horse-power motor runs at 710 revolutions per minute, and is wound for 200 volts, 50 period alternating current. It is coupled direct by means of a flexible coupling which was especially made for Mr. Wightman's purpose by Messrs. Burnands, of Sheffield.

The power is ample for the duty performed, and the machine is stiff and rigid, the holes being accurate and true. The work undertaken in Mr. Wightman's private workshop embraced the design, the patternmaking and all the machining, with the exceptions stated above, and the machine forms an addition to his equipment of small machine tools which he uses purely for the purpose of a hobby and a pastime.

Launch of the Conte Biancamano.

IN a note which appeared in our Seven-day Journal of last week, a brief account was given of the new Italian liner Conte Biancamano, which, on Thursday last, April 23rd, was successfully launched from the Naval Construction Works of William Beardmore and Co., Ltd., Dalmuir. By the courtesy of her builders, we are now enabled to give some further particulars of this fine ship, and to reproduce a photograph of her taken directly after the launch, when she was moored alongside the fitting-out basin. The firm of William Beardmore and Co., Ltd., has been closely associated with the Lloyd Sabaudo Company, of Genoa, ever since May, 1914, when the first ship built for that company was laid down. Unfortunately, the war prevented its completion as a liner, and it was converted into the well-known seaplane carrier H.M.S. Argus. In February, 1922, an 18,000-ton liner, the Conte Rosso, was delivered to the Lloyd Sabaudo Company, and in April of the year following a sister ship, the Conte Verde, was completed for the same owners. These two ships have, we learn, given great satisfaction in service, and have proved very economical, and no important repairs have been necessary.

The Conte Biancamano is the third vessel to be built, and she marks an advance, both in dimensions and speed, on the two earlier ships. She is 55ft. longer, and is broader by 2ft., whilst her gross tonnage will be about 23,000, and her designed service speed 20 knots, which means some 20 per cent. increase in the power of her geared turbine machinery.



THE LLOYD SABAUDO LINER CONTE BIANCAMANO

The following are the leading particulars of the hull and the propelling machinery :—

Hull Particulars.

Length overall	655ft.
Length between perpendiculars	625ft.
Breadth moulded	76ft.
Depth moulded	48ft.
Load draught	26ft.
Gross tonnage, about	23,000
Service speed	20 knots

Designed Passenger Accommodation.

Special first-class passengers	250
First-class passengers	250
Second-class passengers	600
Third-class passengers	650
Officers and crew, about	500
Total ship's complement, about	2250 persons

Main Propelling Machinery.

Type: twin-screw double-reduction geared turbines. Parsons impulse and reaction type.

Total power ahead, designed	24,000 S.H.P.
Total ahead power in service	21,000 S.H.P.
Propeller speed	95 r.p.m.

The vessel has been built under special survey to the highest class of the British Corporation, Registro Nationale Italiane, and Lloyd's. She is subdivided throughout, according to the full standard of the International Convention for the safety of life at sea. In addition, she complies with the latest requirements of the Italian and the United States shipping laws. William Esplen, Son, and Swainston, Ltd., naval architects and consulting engineers, have inspected the hull and machinery during its construction on behalf of the owners.

The view we reproduce does not show the completed superstructure, but sufficient details are given to indicate that the liner when finished will present a handsome appearance. She will have two funnels and two masts, with a straight stem raked forward, and a long elliptical stern bossed out in the region of the water line.

The decoration of the public rooms will again be a special feature, and the work will be carried out to the designs of Messrs. Coppede, who are noted Italian architects. We need hardly mention at this juncture the deck auxiliary machinery and the different safety and navigational services, which will be of the latest type. The lifeboats to be carried will be nested and will accommodate 25 per cent. more than the full complement.

The propelling machinery and boilers were designed and built at Dalmuir and are well advanced. The twin-screw machinery is of the double-reduction geared turbine type, and each set has been designed for a trial output of 12,000 shaft horse-power. It is expected that about 25,000 shaft horse-power total will be developed under service conditions of 20 knots with a propeller speed of 95 revolutions per minute. Steam will be generated in seven double and two single-ended boilers, which are fitted with smoke-tube superheaters and tangential dryers. The boilers are designed for oil fuel and the Wallsend-Howden oil-burning system with forced draught is fitted.

The Conte Biancamano was launched by La Marchesa de la Penne, the wife of the managing director of the Lloyd Sabaudo Company, who was also present. In the absence—through indisposition—of Lord Invernairn, chairman and managing director of William Beardmore and Co., Ltd., the proceedings were presided over by the Marquis of Graham. In July last only the flat and vertical keels of the ship, along with a few floors, were laid, so that work up to the launch has proceeded very rapidly.

H.M.S. Triumph and Her Cylinder Liner.

By Engineer-Captain EDGAR C. SMITH, R.N.

FORTY years ago in February, 1885, H.M.S. Triumph left England for a commission in the Pacific station. An armoured broadside ship of 6640 tons displacement and mounting ten 9in. guns, she was built at Messrs. Palmer's works at Jarrow in 1873, and was engined by Maudslay, Sons and Field. She was 280ft. long, 55ft. beam, and drew 26ft. Her original machinery consisted of a simple expansion return connecting-rod, horizontal engine with two cylinders 98in. in diameter and 4ft. stroke, developing somewhat under 5000 horse-power. The cylinders were on the port side of the ship and the condensers on the starboard side. In the early 'eighties she had been thoroughly overhauled at Portsmouth, a new set of boilers made at Keyham had been fitted, and Maudslays had removed her old cylinders and fitted new.

On her arrival in the Pacific Station an examination led to the discovery—not an uncommon one in those days—of a long circumferential crack in one of the cylinder liners. The Admiralty was informed, the ship was laid up at Esquimault, and the arrival of a new liner was awaited from England. Meanwhile the work of clearing away was proceeded with, the crank shaft being moved over to the condensers, and the defective cylinder being moved towards the centre line. This done the cracked liner was disconnected and drawn, and after a part of the lower deck had been cut away was hoisted on deck.

So far all had been plain sailing, but when the new liner arrived it was found to be about $\frac{3}{4}$in. too large. Esquimault Yard, then in its infancy, contained neither lathe or boring machine large enough to tackle a job over 8ft. in diameter, and chipping and filling the five circumferential fitting strips appeared out of the question. Through the ingenuity of the late Engineer-Commander Josiah P. Thomas, the difficulty was, however, surmounted, and if anyone will turn up "The Royal Navy List, or Who's Who in the Navy," after about 1890, he will find this record against Thomas's name :—

"Thomas, J. P., engineer of the Malabar during the Egyptian War—Egyptian medal, Khedive's Bronze Star—when serving in the Triumph on the Pacific Station during her late commission, the liner of one of her cylinders became cracked and useless, and a new one was sent out from England to replace it, which was found on arrival to be so much too large in diameter that it seemed almost impossible to fit it ; chipping was out of the question, and there were no appliances in the dockyard at Esquimault ; Mr. Thomas, however, conceived the idea of utilising the ship's capstan and a slide rest from a large lathe, together with cutting tools devised for this purpose by himself, and succeeded in making as good a job of the liner as if it had been turned down in one of the home factories, the country was saved some thousands of pounds, and the Triumph was kept efficient on her station by this display of ingenuity, mechanical ability and readiness of resource."

Such is the semi-official statement in the Royal Navy List, to which reference is made for information regarding meritorious service. Most engineers in the Navy had either read or heard of the capstan being used, and the story had the force of a tradition. When collecting material for some lectures on naval engineering two or three years ago, I thought I should like to know more about this interesting piece of work, and Engineer-Commander Thomas having died in 1920, I wrote to three officers who were serving in the ship at the time. These officers were Engineer Rear-Admiral G. C. Bath, Engineer-Captain A. J. Johns, and Commissioned Shipwright J. T. Berry. The outcome of these letters was certainly unexpected, for I then learned for the first time that the cylinder liner was never taken to the capstan, but that the work of reducing the diameter of the fitting strips was all done in the engine-room by hand. Admiral Bath's letter will make this plain.

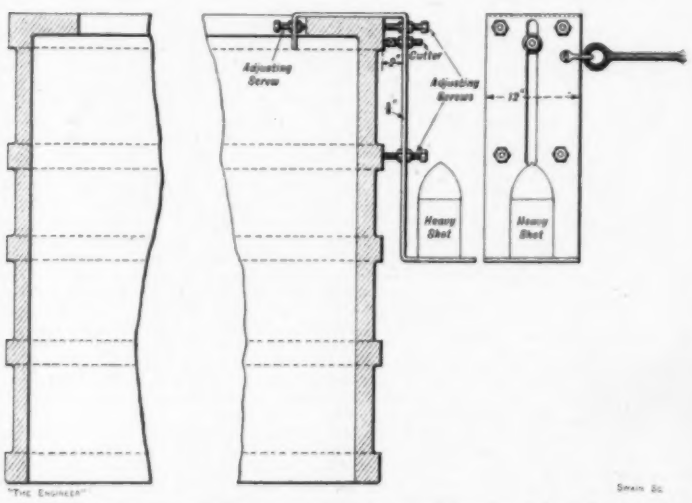
"When the new liner arrived it was found in gauging that it was too large for the cylinder. It was lowered into the engine-room on to a platform of 12in. square baulks of timber and stood on end. To reduce the diameter a stout piece of boiler plate was bent to the shape shown in the accompanying rough sketch, the top being hooked over the end of the liner, and it was weighted by placing a 9in. shell on the shelf at the bottom, the whole being steadied as far as possible by distance pieces and flat-nosed set screws.

"A tool rest was arranged attached to the plate, and the whole was pulled round and round by three or four men on a rope's end. Some little difficulty was experienced, but eventually a steady and even cut was obtained, although, of course, it had to be a very thin one.

"The liner was fitted in place and everything replaced and connected up without any mishap, and the ship completed a four years' commission on the station. The whole of the work was done by the ship's staff without any outside assistance."

This new light on the turning of the liner was corroborated by Mr. Berry, who cut away the lower deck and supplied the timber baulks, and by a stroke of good fortune Engineer-Captain Johns found among his papers the original sketch showing the plate, the projectile, the flat-nosed set screws, the cutter and the rope by means of which the whole was pulled round. It is from this sketch that the accompanying illustration has been prepared.

How the tradition arose and how it got into print that the liner was turned on the capstan will probably remain unknown. Sir James Wright was then Engineer-in-Chief of the Navy, and he and his successors, Inspector of Machinery Richard Sennett and Engineer Vice-Admiral Durston, have all passed away. But whatever the explanation it will not be denied that the method used displayed "ingenuity, mechanical ability and readiness of resource."



SKETCH SHOWING METHOD OF REDUCING DIAMETER OF CYLINDER LINER

A New Relay.

A PAPER by Mr. George Lewis in the November issue of the "Journal" of the American Institute of Electrical Engineers describes a sensitive radio frequency relay. It has been developed to control currents as great as 5 ampères by means of extremely small operating currents of any frequency, and it is thought that it will prove useful in connection with radio and carrier current systems. The operation of the relay is based upon the employment of the kinetic energy of the thermionic discharge brought about by an emission element such as a filament, the discharge being directed upon a sensitive responsive anode. The impact of the electron stream upon the anode results in the expenditure of the kinetic energy of the bombarding stream.

The relay has four main elements—a cathode which produces the electron stream, means for controlling the electron emission flow, a sensitive responsive anode, a movable contact arm, and a stationary contact for the control of an external circuit. The cathode element consists of a platinum-iridium strip having a new kind of oxide coating, which gives the cathode a high thermionic efficiency and a long life. The strip is suspended parallel to the responsive anode, which is composed of nichrome and is attached at one end to the movable control arm of the make and break device, which is controlled by the movement of the anode, which responds to the impact of the electron stream upon it. The electron discharge from the filament is electrostatically controlled by a grid element interposed between the filament and anode, so that in operation the grid controls the anode movement by virtue of its control of the electron stream.

By means of a local circuit the anode is maintained at a temperature which gives a very small space between it and the stationary contact. This close contact spacing, without any tendency to arc even when the external circuit carries a current at considerable potential, is made possible by the high degree of evacuation to which the tube is subjected before the sealing-off process is completed, and, as the necessary slight movement of the control arm of the make and break device is controlled by the thermo-expansive anode, the operating speed of the device is high as compared with the usual thermal devices. The impact of the electron stream upon the anode results in a slight mechanical effort, a negligible radiation at low wave length, and a temperature rise of the anode. The temperature rise of the anode is, however, the main effect.

The diagram—Fig. 1—shows the connections for a relay of this type. The relay is operated by incoming signals, and it controls a signalling device such as an electric bell. The anode is connected so that its energising circuit is partially short-circuited when the contact of the relay circuit is closed, thus causing the anode to cool by radiation and so causing the circuit to open.

By this rapid heating and cooling of the anode element the relay contact opens and closes the external circuit at a rate of about twenty times per second. The relay can be employed in this manner for radio or carrier wave circuits for either telegraphy or telephony, and when used in this manner all the circuits can be supplied with energy from a single transformer as shown. To keep the adjustments constant and independent of line variations, a special ballast lamp is used. The lamp has two resistance elements, which are placed in a tube filled with hydrogen. One element is composed of iron and controls a current flowing to the primary of the transformer, and it is operated at a temperature of about 500 deg. Cent., because at that temperature iron has an exceedingly large resistance coefficient. The other element is composed of nichrome wire, which is directly connected across the line, and its temperature is adjusted by means of an external resistance so as to bring the controlling iron resistance element to a proper temperature. When the resistances are properly adjusted large variations in the line potential are compensated for, and the relay adjustment is stable. The diagram—Fig. 2—shows the same circuit with a change-over switch to allow the use of telephone receivers in the plate circuit.

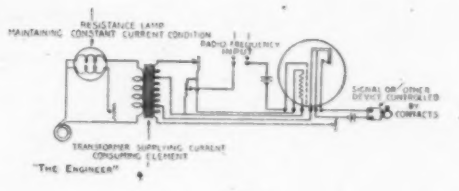

RESISTANCE LAMP MAINTAINING CONSTANT CURRENT CONDITION
RADIO FREQUENCY INPUT
SIGNAL OR OTHER DEVICE CONTROLLED BY CONTACTS
TRANSFORMER SUPPLYING CURRENT CONSUMING ELEMENT
"THE ENGINEER"

FIG. 1

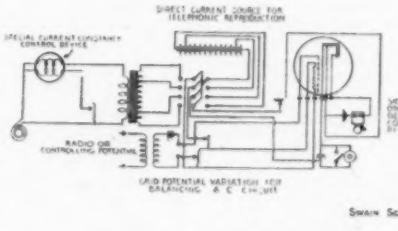

DIRECT CURRENT SOURCE FOR THERMIONIC REPRODUCTION
SPECIAL CURRENT RESISTANCE CONTROL DEVICE
SIGNAL OR OTHER DEVICE CONTROLLED BY CONTACTS
RADIO OR CONTROLLING POTENTIAL
GRID POTENTIAL VARIATION FOR BALANCING
SWAIN SC.

FIG. 2

Garratt Locomotives for South African Railways.

SIX class "G. E." Garratt locomotives, ordered from Beyer, Peacock and Co., Ltd., are now being erected in the Pretoria workshops. These engines are the largest and heaviest of the Garratt type yet ordered for the Union of South Africa, their total weight complete and in working order being in the region of 145 tons, while the coupled wheels axle load is a little over 12½ tons. Having a comparatively light axle load, they will be suitable for working over sections laid with 60 lb. rails, such as the Zeerust line, where the engines are to be sent when erected. They will be chiefly engaged in hauling heavy goods traffic, and, owing to their high tractive effort of 46,142 lb. at 75 per cent. boiler pressure, they will undoubtedly be of great assistance in coping with the work of transport on this extremely busy section.

The wheel distribution is of the 2-8-2—2-8-2 type, each engine unit having a leading bissel bogie, with wheels 2ft. 4½in. diameter, eight coupled wheels 3ft. 9½in. diameter, and trailing carrier wheels 2ft. 4½in. diameter. The cylinders are 18in. diameter by 24in. stroke, and are fitted with piston valves. The boiler, which has a Belpaire fire-box, is 6ft. 9in. inside diameter at the first ring, and 11ft. 9in. long in the barrel. The safety valves, four in number, are of the Ramsbottom type, and are set to blow off at 180 lb. per square inch. There are 288 boiler tubes, 2in. diameter, and 36 flue tubes, 5½in. diameter, giving a heating surface of approximately 2367 square feet.

The fire-box, 7ft. 10¾in. by 6ft. 7in. at base, is constructed of steel plates, $\frac{7}{16}$in. thick at sides, crown and back plate, the tube plate being $\frac{1}{2}$in. thick. The grate area is 51.65 square feet. The boiler is equipped with a superheater, the element tubes being 1¼in. outside diameter, giving an approximate superheater area of 440 square feet. The boiler, which is interchangeable with the G. A. type, is carried on a girder or cradle frame, which pivots on the engine frames at each end, the pivot centres being accurately determined, so that the weight of the boiler and frames is distributed evenly on both engine units. The great advantage of having the boiler carried on its own frame is that practically unlimited space is available for a fire-box of suitable proportions, thus ensuring the most efficient steaming of the engine. At the front and back of the boiler the two engine units are arranged, each working independently of the boiler frame, by the action of the pivot centres. On each frame a tank is carried, that in front being used exclusively for water and having a capacity of 3350 gallons ; the hind tank operates as a tender, being constructed to carry 1250 gallons of water and 9 tons of coal. A water-filling hole is provided on the top of the leading tank, and the water is conveyed to the rear tank through pipes. The steam pipes, which lead from the header in the smoke-box, one to the front engine and one to the hind engine, are provided with cut-out valves, so that either unit may be worked independently in cases of emergency. These valves are arranged immediately beneath the smoke-box.

From the smoke-box the steam pipes lead to a ball and socket joint situated directly under the pivot centres, and thence through an expansion joint to a breeches pipe with branches extending to each cylinder steam chest. The steam pipes are of weldless steel, and are covered throughout their lengths with asbestos. The exhaust steam pipes lead from the cylinder through a Y piece, and thence to a ball and socket joint at the pivot centres, and then on to the base of the blast pipe beneath the smoke-box. The blast pipe is arranged with two legs, one taking the exhaust pipe from the front engine and one from the hind engine. Eight sand boxes, four on each unit, are fitted in suitable positions, and are equipped with the "Lambert" sanding apparatus for applying sand to the rails. The axle-boxes for the coupled wheels are of cast steel, with an oil receptacle on top and a bronze liner on the face next to the wheel boss. The bearings pressed into the box are of bronze with white metal pockets. Mechanical lubricators are provided on each frame to supply oil to the bronze liner next to wheel boss and to the horns.

The valve motion is of the Walschaerts' type, and is controlled by means of a steam reversing gear, which is mounted on one side of the boiler frame. The whole of the motion work has been kept as light as possible. The springs for the coupled wheels are of the semi-elliptical laminated type, arranged beneath the axle-boxes; they

are compensated throughout, having a break between the leading and intermediate coupled wheels. The total engine wheel base is 69ft. 10in., and the total fixed wheel base 12ft. 9in. The height from rail level to the boiler centre is 7ft. 9in., and from rail to top of chimney 12ft. 10in.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Market Depression.

THE depression in the iron and steel industries of the Midlands and Staffordshire shows no signs of lifting, and pessimism is becoming prevalent. Many iron and steel masters do not now hold out any hope of real improvement this quarter, while others, bearing in mind the approaching usual quiet summer period, express their inability to forecast any revival before September. There is a complete absence of anything on which to found real hopes of a speedy improvement, and were it not that some branches of engineering, including rolling stock building, have a fair amount of work in hand, and moderately good prospects, producers of raw materials would be even more despondent. The usual weekly market in Birmingham to-day—Thursday—was fairly well attended, but it produced very little addition to the business in hand.

Steel Position.

The state of the steel trade is causing no little concern, although heavy engineering firms appear to be showing a slight improvement. The recent decision of the steel makers to abandon price regulation giving every manufacturer a free hand to quote his own price, is equivalent to the collapse of the Association, but it is quite a usual experience during a period of depression. It is significant, however, of the fine cutting of prices that the reduction following the abandonment of price regulation has in no case exceeded 5s. per ton. Plates remain firm on the reduced basis of £9 10s. in this district, and joists, angles and sections at £8 10s. With the agreement for the regulation of selling prices annulled competition has quickened, particularly in relation to ship, bridge and tank plates. North East and Scottish mills offer plates in this district at £9 10s. Taking into account the cost of transport, it is quite credible that business has been done in the North at less than £9, so that the consumers in this district are left a good deal worse off. Local producers consider this sort of competition is calculated to defeat its own ends in the present impoverished state of the market. Competition is likely to be intensified all round, and it will become a question for many producers whether the business is worth having at the price. Rather more material is going into structural engineering enterprises, but the home makers find it difficult to get business owing to the low rates quoted by foreign shippers. A matter of some practical importance is the reduction in the price of native billets, which for some time have been firm at £7, but are now quoted at £6 17s. 6d. One large Welsh firm is taking business at £6 15s. Belgian prices are slightly firmer than they were being quoted at £6 6s., and sheet bars £6 8s., a rise of 1s. per ton. As a rule, an advantage of 10s. per ton is not sufficient to divert the business to the Continent, and in this line, the native product may once more be regarded as competitive, especially in view of the much quicker deliveries which can be made by home mills. The retaining of this substantial business would be a most useful help to Midland steel works.

Raw Iron Price Deterioration.

Pig iron prices continue to deteriorate despite the efforts of Midland blast-furnacemen to keep them up. Last week Northamptonshire brands were shaded, but Derbyshire smelters held firmly to recent quotations. This week values have fallen fully 1s. 6d. per ton. Northamptonshire foundry could be bought on 'Change in Birmingham to-day at £3 10s. at furnaces, and Derbyshire at £3 15s. to £3 16s. The trade in forge qualities is almost negligible, and it would be difficult to determine what would be an acceptable price for an order of any size. Though pig iron consumers have very little material in stock, they continue to buy only for immediate requirements, and practically every order is accompanied by appeals for quick delivery. Blast-furnace coke is cheaper—moderately good grades can be bought at 15s. at ovens—and this is assisting smelters, but pig iron cannot be put on the market at the prices to which it has been forced down. The position is extremely unsatisfactory, and there is talk of further furnaces being blown out.

Staffordshire Bars.

The Staffordshire finished iron trade is inert. Orders are small, and are not placed, as a rule, till the material is required for consumption. A few more orders have been given out for ordinary wrought iron, for which there is still a decided preference over steel. Work consists mostly of steel re-rolling, either for wagon builders, who continue busy, or for the varied requirements of the numerous working-up trades of the Birmingham area. The marked bar houses are best off in the iron department, but could do with more work. Scotch makers of malleable iron have reduced their prices by 7s. 6d. per ton. This, however, is hardly likely to affect this district for Scotland specialises on export orders, few of which now come to South Staffordshire. A matter of more concern to Staffordshire makers is the low price of No. 3 Belgian nut and bolt iron, which can be bought at £7 delivered, or more than £4 below the price of Staffordshire bars for the same purpose.

Sheet Values.

The galvanised sheet trade continues the bright spot in the market, and the home inquiry having shown further improvement, makers have been able to raise their basis for 24-gauge galvanised corrugated sheets to £16 15s. for home business, £16 12s. 6d. for export. For small lots 2s. 6d. more is being asked. Extras are being less rigidly enforced in the thinner gauges. The tin-plate trade remains quiet at the minimum rates, and there is some slight speculation on the chances of a further fall.

Engineering.

Employment in the Midland engineering trade remains steady, but future prospects are, to a certain extent, bound up in the success of the new negotiations in regard to wages and hours. Until these are settled firms will experience some difficulty in tendering. A slight improvement in business is reported by local constructional engineering firms, and there is hope for its continuance in view of the number of inquiries being made by local authorites for new bridges and works of a similar character. Tenders for a steel bridge under the London, Midland and Scottish Railway at Tipton, South Staffordshire, and also one for the Sunderland Corporation, are being asked for.

Rolling Stock Contracts.

Further rolling stock orders have recently come to Midland wagon works. They include contracts for "bogie bolster" or long-rail wagons for the London, Midland and Scottish Railway, which have been placed with the Metropolitan Carriage, Wagon and Finance Company and the Midland Railway Carriage and Wagon Company, both of Birmingham.

Colliery Electrification.

A new departure has been made in the Cannock Chase coalfields by the electrification of one colliery with power supplied by a neighbouring colliery company. This is an example of co-operation in the coal industry, which is of considerable interest. The Conduit Collieries at Norton Canes are among the oldest and best known in the Chase area, and faced with the need for modernising the plant, the company has abandoned practically all its steam equipment, with the exception of winding, and introduced electrical haulage gear, coal cutters &c., which are driven by current obtained from the Cannock Chase Colliery Company. The latter company has recently completed a large new power station at Chase Terrace, in which it has installed a 150-kilowatt turbine, and from this station the current is carried by overhead cable to the Conduit Collieries, a mile and a-half away. The Conduit Company is in this way able to get the benefits of electrification without the expenditure of the very heavy capital that would have been required for the provision of its own power station. This is the first instance in the local coalfields in which two distinct colliery companies have co-operated in the manner indicated.

Old Hill Pit to Close.

It is understood that R. Fellows, Ltd., has decided to close the Black Wagon Colliery, Old Hill, within the next few weeks. This step has been taken in consequence of the unremunerative nature of the pit. Operations have already ceased in a portion of the workings, and the remainder will be closed shortly. The colliery was originally opened eighty years ago, but was closed in 1895, when the large works of the New British Iron Company were demolished, owing to trade depression. It was reopened four years ago, when the view was held by the firm that it could be run satisfactorily. Trade conditions have, however, failed to improve.

Colliery Changes at Holly Bank.

Some 200 miners, employed by the Holly Bank Colliery Company (Limited) at its No. 15 pit at Essington, have received notice to terminate their agreements, but they will be offered work at the new Hilton Main Pit of the company, and it is expected that the bulk of the men will merely transfer their services. The Hilton pit is a modern electrified mine, and when it was opened some months ago, it was made clear that in due course it would supersede the Holly Bank pits.

Unemployment.

The effect of the Easter respite is still reflected in the returns issued by the Ministry of Labour, showing the number unemployed in the Midlands. The current total of 141,692 is 10,496 greater than it was for April 13th, the date of the previous return, and 11,153 greater than it was on March 30th. The position is similar to that shown by the figures after the Christmas holidays. The latest total is made up of 102,051 men, 2209 boys, 34,375 women, and 3057 girls. The returns for the principal towns are :—Birmingham area, 26,524 ; Coventry, 1427 ; Bilston, 3914 ; Cradley Heath, 6088 ; Derby, 1717 ; Dudley, 3786 ; Leamington and Warwick, 415 ; Leicester, 3585 ; Northampton, 1629 ; Nottingham, 9958 ; Oldbury, 1642 ; Peterborough, 521 ; Redditch, 1084 ; Smethwick, 4618 ; Stoke-on-Trent area, 15,517 ; Stourbridge and Brierley Hill, 3643 ; Tipton, 2383 ; Walsall, 5969 ; West Bromwich, 3379 ; Wolverhampton, 5177 ; Worcester, 1730 ; and Wednesbury, 3691.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

THERE has been no improvement yet in the iron and steel section of the metal trades, although the partial recovery from the slump in the non-ferrous metal markets has brought about a more cheerful feeling. The proposal of the master engineers for a longer working week has led to the fear that industrial trouble is near at hand ; for it is fairly certain that, however wise and necessary may be the proposal, the unions will not listen to it. That men must work longer and harder if the export trade of the country is to be saved, is no doubt an unpleasant truth ; but there must be a fierce and prolonged struggle before it is recognised as inevitable. Meanwhile what trade there is will suffer. Both shipbuilding and general engineering must be in a much better state than they are now before any revival in the iron and steel trade is possible, and apparently we shall have sagging markets in this department for a long time yet.

Metals.

The reaction in the copper market after the recent fall has not yet engendered any confidence in the minds of buyers here. In fact, the speculative element in the market seems more disposed towards selling than buying, as it is not believed that the general position is really any better than it was. There have been reports that the American output of copper is being cut down, and rumours of buying by important merchant firms, and possibly these have been the cause of the recovery from the very low prices ; but, on the other hand, the American domestic demand is smaller, and there is no indication yet that the European buying will make up for this. Undoubtedly, it is very difficult to come to any definite view one way or the other as to the prospects of the copper market ; but, of course, it must always be borne in mind that present prices are very low, as compared with iron and steel, and with all the other non-ferrous metals. There have been slight reductions in manufactured copper and brass, but prices in this section of the metal trades are still very much higher than they should be. The fact that German builders could take a locomotive contract at two-thirds of the lowest British tender is ample proof that British engineers are working against impossible conditions as regards cost. The condition of the scrap metals trade here is very poor, and dealers are paying only low prices. There is, however, quite a substantial margin between the prices paid by dealers here and the selling prices. Thus, ordinary mixed gun-metal scrap is bought at £45 to £46 per ton, but £50 and even more is quoted on sales. For heavy yellow brass dealers here offer £40 per ton and for light collected brass scrap, £36 to £37. The market for tin has been rather erratic again, and consumers here seem to have given up the attempt to understand it. A little while ago they were confident that it was moving towards the £200 level ; now they are fearing a £250 level American buying, coming rather unexpectedly, seems to have been the cause of the late movements. If the statistics are good at the end of the month, we may see present prices maintained, or even improved, but the outlook is altogether uncertain. The market sentiment in lead seems now to be more favourable. Until the check to the fall occurred, people here were very pessimistic, but the reverse feeling is predominant now perhaps to rather too great an extent. Spelter has moved in sympathy with lead, but there is little change in the position.

Pig Iron.

The markets here for foundry iron remain very dull and quiet, but it is very difficult now to get prices down. During the present year there has been a fall of some 5s. to 6s. per ton, and that on a market in which it has been the constant theory of makers that no profits were left, and that there was no margin for lower prices. Consumers here are therefore inclined to argue that although there may be no profits, a further fall of 5s. is still quite possible. Of course, it is also a common argument that Derbyshire and Staffordshire furnaces ought to be able to produce common foundry iron as cheaply as the Northamptonshire makers, and hence that Derbyshire iron ought to be at 71s. 6d. on trucks at the furnaces instead of 77s. 6d. However this may be, it will evidently take a long time to get pig iron prices much lower than they are now. Trade here is still largely of a hand-to-mouth character, but the prices for No. 3 foundry iron are fairly steady at from 84s. to 85s. per ton delivered in Manchester. Scotch iron has been reduced by 2s. at the furnaces, but it does not seem to make much difference here. The use of Scotch iron for foundry purposes is dying out, and one sees no chance of restoring it until the iron can be brought into Manchester at a reasonable rate of carriage. Hematite iron from the East Coast is, of course, much cheaper than Scotch iron, and even this is not used extensively by the ordinary ironfounder.

Finished Steel.

The markets for finished steel are dull in the extreme. Buyers were very few and far between before the steel makers decided to have free competition ; and now they are fewer, for many of them are holding back with the idea that, as there are four or five sellers to every buyer, prices must come down quickly. Nominally, the prices here for joists and angles is £8 10s. delivered and for steel plates £9 7s. 6d.; but it is quite generally believed that lower prices than these would be accepted. There is, of course, the usual argument against any serious fall, viz., that steel is being made at a loss ; but until works close down, or, on the other hand, there is a revival in consumption, it is difficult to see how prices can be maintained.

Scrap.

In the market for steel melting scrap there is now very great depression. There is no steady demand, and the very intermittent buying from Sheffield cannot sustain prices. Dealers here seem to be hesitating whether it is safe to buy melting steel scrap at 55s. per ton, but at present from 55s. to 57s. 6d. is still being paid. Wrought scrap is not plentiful, and there is a small demand for it at 80s. to 82s. 6d. per ton at the works. For cast scrap, there is not much demand here now ; but, on the other hand, dealers have no very large stocks and fresh supplies are not coming in very well. Consequently, sellers seem fairly firm, quoting 80s. to 82s. 6d. for ordinary machinery, and up to 85s. and even 87s. 6d. for textile ; but there is little buying by the founders.

Steam Boiler Insurance.

The new Factory Bill which was introduced into Parliament last year was criticised by Mr. Harold Lee,

the President of the Manchester Steam Users' Association, at a meeting of steam users held in Manchester last Friday. It was to the clauses connected with the inspection of boilers that he objected. He said that the chief engineer of the Association had been informed by the Home Office that the boiler insurance companies had been consulted with regard to these clauses, but their Association had received no notice to attend the meeting. Boiler owners did not wish to live in fear of unforseen explosions, whereas for insurance companies explosions were merely chance events which had to be allowed for in fixing premiums. He said that the meeting had been called in order to obtain a hearing for boiler owners. He did not claim that their Association's system was the only safe one, and they were ready to admit that another group of boiler owners, if faced with the problem, might adopt another equally efficient system of inspection; but they felt confident that Government officials and insurance companies, if left to themselves, would never be able to do what that Association had done. It had, during the past seventy years, made over half a million boiler inspections, and in no single case in which it had issued a certificate of safety had there been a preventable explosion. Mr. Lee added that when a Government Department dealt with a subject it was a question of "safety first for the officials." When business interests dealt with such a subject, profit was the first consideration; but boiler owners were primarily interested in the safety of their boilers.

A Strike Ended.

The strike of the members of the Electrical Trade Union, which began on March 8th, came to an end on Saturday last. The members of this union were engaged in maintenance work on the overhead wires for the Manchester and Salford Tramways Committee, and their demand was for an increase in wages of 4d. per hour. In reply, the Lancashire and Cheshire Municipal Authorities' Association offered an advance of 8s. per week for electrical tradesmen and 4s. per week for linesmen, and that offer was ultimately accepted. These increases bring the weekly earnings up to £3 13s. in the case of the electrical tradesmen and £3 12s. 8d. and £3 8s. 6d. for the two categories of linesmen.

Manchester Tramways Construction.

I had an opportunity a few days ago of inspecting a section of new tramway track which is being constructed by the tramway engineer of the Manchester Corporation, Mr. H. Mattinson, M. Inst. C.E., along one of the new arterial roads. Two lines of rails are laid in a reserved portion of the road, 28ft. wide, leaving two carriageways on either side, 20ft. wide, and footpaths, 16ft. wide. The tramway area is guarded by kerbs, 6in. high, above the road surface, and the rails are secured to wooden sleepers laid on stone ballast on a bed of cinders, with longitudinal land drains on either side. The sleepers are of creosoted red deal, pitched 2ft. 9in. between centres and 2ft. at the joints. The rails are held in position by mild steel clip plates with two coach screws to each plate. They are of dwarf section, 5in. deep, and weigh 97¼ lb. per lineal yard. The fish-plates have four bolts and nuts, and allowance is made for expansion and contraction of the rails. Vehicular traffic will be able to cross the tracks at defined points, and the crossing-places will be finished with a smooth rock asphalt surface. At each crossing-place pillars are provided with red lights, showing in all directions at night, and landing-places are provided for passengers boarding or alighting from the cars. The overhead construction is carried by centre poles. The work is being carried out largely by means of "unemployed" labour."

BARROW-IN-FURNESS.

Hematite.

There is evidence of the dulness of the hematite pig iron market in the fact that stocks are accumulating at some of the works. Up to the present, these stocks have not assumed large proportions, but if trade does not improve immediately, they will do so unless there a few furnaces are put out of commission. There must be some optimism in the district or there would have been a restriction of output before this. The trade with Scottish buyers is very dull, owing to the quietness in business generally, and the same remark can to a certain extent be applied to the Midlands, customers in that district only requiring small tonnages, and only taking what they need for immediate purposes. The trade with the Continent is very small indeed, and consists of a few cargoes or part cargoes now and then. American business fluctuates and occasional orders are booked. Barrow has an American order to deal with at present. The demand for special qualities is small, owing to the fact that many engineering firms have not much work in hand.

Iron Ore.

The iron ore trade is only moderately active, and as it relies upon local consumers for most of its orders, little being sent out of the district, the outlook is not very bright, for as soon as there is a stoppage of some of the furnaces there will be less ore brought up. Some of the mines in the Furness district have introduced electrical power, which they get from the Barrow Corporation, and are benefiting by the economy. Other mines are inquiring about a supply. The trade in foreign ore is moderate, and there are regular cargoes coming from Kirkenes.

Steel.

There is no alteration in the steel trade. There are orders to keep the rail mills going at Barrow for a few weeks, but fresh orders are needed. The rail mills at Moss Bay are only partially employed. At Barrow the Siemens department and the foundries are at work. The hoop and small section mills are better situated.

Shipbuilding and Engineering.

Work is progressing rapidly on the Cunard liner Carinthia, and her funnel and masts have been stepped. The large Orient liner Otranto will be launched in June. Vickers have booked an order for a small floating dock, intended for dealing with canal boats on the Cheshire canals.

SHEFFIELD.

(From our own Correspondent.)

Steel Trade Conditions.

THERE is no improvement to report in the condition of the steel trade, and, on the heavy side at any rate, things appear to be worse instead of better than they were before the Easter stoppage. A considerable proportion of the large works have resumed operations on a reduced production basis. At the Templeborough works of United Steel Companies, Ltd., both the melting and mechanical plants remained standing until this week. Billet makers report that neither the orders nor the inquiries coming in represent any bulk of work, and the policy of producing for stock is not justified by the outlook. The scrap market is very quiet, and heavy steel scrap has fallen to 70s. or less. Owing to the serious fall in colliery requirements, and the quietude of the engineering trades generally, one of the largest steel foundries has adopted short-time working. At other foundries, there is a moderate amount of employment. The state of things in North Lincolnshire also grows more serious. Already, over 1000 men are out of work as the result of the closing down of the Redbourn Hill and North Lincolnshire works, and now the 1400 men employed at the Normanby Park Steel Works have been put on fourteen days' notice. It is not anticipated, however, that this notice will be acted upon. It has been given as a measure of convenience, and the men will continue to work on a day-to-day engagement.

The Lighter Side.

There is nothing to add to recent reports with regard to crucible steel and tools. The former branch, which is of much importance, is in a very quiet state, while the falling off in the demand for files and engineers' small tools still continues. One fairly busy department is that engaged in the manufacture of implement parts, including knives, reaper sections, and various steel parts and castings. The city has many overseas connections for this trade, which is an old and valuable one. The agricultural implement industry has been rather better employed than it was last year, but very strong competition from France is being encountered.

A New Sheet Mill.

A new sheet mill, which has just been installed at the works of John Wood and Sons, Ltd., Wisewood, Sheffield, was started up on Monday. The mill will deal with all kinds of sheets up to 32in. in width and up to 26 gauge, and it is intended ultimately to make provision for sheets up to 38in. in width. All kinds of sheets will be rolled, but the firm will specialise more particularly in sheets for the circular saw trade, and, with this in view, the most modern machines for paring and finishing sheets have been installed. The mill will be a valuable addition to the rolling mills of the firm, which has a high reputation for special alloy steels of all kinds. The mill has been designed, built and erected by the Brightside Foundry and Engineering Company, Ltd., Sheffield. It is electrically driven by a 250 horse-power motor through a 20-ton fly-wheel set. At present it comprises one pair of roughing and one pair of finishing housings, and crocodile shears driven from the mill shaft, although, as stated above, it is intended ultimately to add a second pair of housings for the finishing of wider sheets.

Cutlery and Plate.

An unsatisfactory state of things continues in most branches of these trades. The demand for stainless knives, which fell off a few weeks ago, has not recovered its old proportions. Makers of the cheaper grades of this cutlery are finding it increasingly difficult to secure orders. Firms which have refused to lower their standard of quality have suffered in the past from the competition of lower grades, but they state that there is a growing revolt against inferior goods, and express confidence in the future success of their policy. Several good orders for high-class ivory cutlery have been booked during the past week. The grinding of table blades by machinery is now practised on a large scale, and the increased adoption of this process is likely. At several high-class works, machines are now used for grinding the best blades, but in these cases the work is finished by skilled hand labour.

Railway Supplies.

Orders from the railway companies are still providing a good deal of work in the local tire, axle, spring and buffer departments. New contracts are not being received as fast as the old ones are worked off, and there is a shortage of work from overseas. Official statistics show that, although this country's share of Indian railway orders may be less than formerly, the great bulk of the work still comes here. In the fifteen months ended March 26th, the Indian Government placed in the United Kingdom orders for railway stock and stores to a value of £923,000, out of a total of £1,249,000; while the Indian railway companies placed orders with British firms for £5,430,000 worth of goods, out of a total of £6,362,000. Sheffield and district firms are interested in the latest orders given out by the London, Midland and Scottish Railway Company. Vickers Ltd., Barrow, are to make a 4–6–0 passenger tender (experiment); Ruston and Hornsby, Lincoln, a 2–4–0 passenger tender and an 0–6–0 freight tender; and the Vulcan Foundry, Newton-le-Willows, a 4-6-0 freight tender. Further contracts for "bogie bolster" or long-rail wagons have been placed with the Metropolitan Carriage, Wagon and Finance Company, Ltd., Birmingham (Vickers Ltd.), the Midland Railway Carriage and Wagon Company, Birmingham (Cammell Laird and Co., Ltd.), and Clayton Wagons, Ltd., Lincoln.

Engines Instead of Pit Ponies.

Some time ago Mr. Charles Markham, chairman of the Staveley Coal and Iron Company, offered a prize of £1000 for the best electric locomotive suitable for underground work at a colliery, his object being to devise a system of haulage which would obviate the use of pit ponies. Five firms have now produced models for the competition, and they will be tested at Brodsworth Colliery next week. They have been made by the Metropolitan-Vickers Company, Manchester; Messrs. Pattersons, Newcastle; Thomas Broadbent and Sons, Ltd., Huddersfield; Armstrong, Whitworth and Co., Ltd., Newcastle; and Hawthorn, Leslie and Co., Ltd., Newcastle. It is stipulated that none of the models must be more than 3ft. 6in. high; the frame of the engine must have a certain clearance from the track, and, when rounding a curve, must not overhang more than 12in.; the vehicle must be gas-proof, and dust-proof as far as possible, and there must be no possibility of gas being ignited from the mechanism.

Other Mining Matters.

In the Railway and Canal Commission Court last week, Earl Fitzwilliam was successful in an application for rights to work about 25 acres of the Parkgate seam of coal at Greasborough, near Rotherham. His lordship already works about 4000 acres surrounding the small areas which the application concerned. It was stated that the coal is 6ft. thick, and is situated at a depth of 360ft. It was proposed to work 5ft. of it on the half-and-half system, leaving half as pillars for support. Another matter of interest to the coal trade is the proposition of the London, Midland and Scottish Railway Company to widen its Doe Lea branch, which is at present a single line, between Seymour Junction and Barrow Hill, Staveley. The line is one which serves many of the most important collieries in East Derbyshire. Out of funds provided by Major G. H. Peake, the Midland Institute of Mining Engineers has established a travelling scholarship in mining research. The value is £50 for one year. The competition is open to young members of the Institute, and the successful candidate will be required to devote not less than three months to the special study of coal mining in any district other than that in which he is being regularly trained as a mining engineer, not more than one month to be spent at any individual colliery.

More Scarborough Schemes.

Several important schemes are in contemplation at Scarborough, in addition to those which have been referred to in recent weeks. One of more than common magnitude relates to the reconstruction of the Valley Bridge, the tenders for which are now under consideration by the Works Sub-committee of the Corporation. The original estimate of the cost of the work was £130,000, but the tenders vary from about £159,000 to considerably over £200,000. A State grant of 65 per cent. of the cost has been promised in respect of the approved scheme. Another project before Scarborough is that of an extension of the waterworks. Dr. Herbert Lepworth, who was asked to report on the matter some time ago, has submitted recommendations for the erection of a new well and pumping station at Irton, and the covering of the Osgodby reservoir, at a total cost of £82,480, and plans are now to be prepared and tenders invited.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

A QUIET tone still prevails in the Cleveland pig iron trade, but the market is not so utterly lifeless as it was a week or two ago. Shipments have shown a considerable improvement during April, but the volume of export trade still leaves much to be desired, and home industrial requirements are still very limited. These latter, too, are further restricted by the reluctance of buyers to place orders on a falling market, and practically the whole of the business now passing is for prompt lots to cover pressing needs. No doubt if stability could be assured there would be some forward buying, as it is believed that many of the consuming works are bare of stocks, but the steady drop in prices appears to have destroyed all confidence. Makers, of course, are fully alive to the need for stabilising prices, but it is not a matter entirely within their control. Still market quotations have now got down to a figure which can scarcely be cut any further, and prices are certainly steadier. For No. 3 Cleveland pig iron 77s. per ton is still the nominal quotation, and there is no doubt that a substantial order could be placed at less. No. 1 foundry iron is unchanged at 82s., whilst No. 4 foundry is quoted at 76s., and No. 4 forge at 75s.

Hematite Pig Iron.

There is little new to report in the East Coast hematite pig iron trade. The output being now limited to ten blast-furnaces, demand should quickly overtake the supply, though at present there are substantial stocks to liquidate, and makers are keen sellers at 82s. per ton for mixed numbers, and 82s. 6d. for No. 1.

Ironmaking Materials.

The foreign ore trade is lifeless, and dealers are experiencing a very difficult time. Consumers show little interest in the market position, and only an odd sale is heard of now and again. Best Rubio ore is quite nominal at 22s. per ton c.i.f. Tees. Good Durham furnace coke is still obtainable at 22s. per ton delivered at the works, although some of the makers are holding out for 22s. 6d. per ton delivered.

Manufactured Iron and Steel.

There is still a very despondent tone in the manufactured iron and steel trade. With productive capacity

increased, firms are unable to find full employment for their plant, and it is a case of operating only the units capable of most economical production. Prices have not receded further. The market is now free, but makers are unable to make any more concessions and recent quotations are practically unchanged.

Shaft Sinking Operations Stopped.

The Wallsend and Hebburn Company, Ltd., has decided to stop operations on the work of sinking a new shaft at Monkton, Jarrow. The decision, it is understood, is due to financial reasons in consequence of the depressed state of the coal trade and the unfavourable outlook. The sinking of the shaft was begun about two years ago and a large sum of money has been expended on the enterprise. A depth of about 300 yards has been reached, and expensive electrical and other plant installed. Surface buildings, including engine-house and coal bunkers, and semi-detached houses for the workmen have also been provided. The new shaft was intended to assist working arrangements underground. By using the shaft the miners would have been saved long walking distances. Coal was not to be brought to the surface under the original scheme, but it would be lifted or lowered to different levels in the shaft with the object of facilitating working conditions in new and old districts underground.

The Coal Trade.

The Northern coal trade has developed a little strength, and the position is more satisfactory than it has been for some considerable time past. There is a fairly good inquiry circulating, and as producers are already well placed with orders for a fortnight ahead, holders are inclined to stand out for some increase in value. There has been a marked improvement in the demand for best Northumberland steam coals and for coking coals. In each of these grades the position has become a good deal firmer, and all available supplies have been taken up for the first half of next month. While these orders are very welcome, they have not much bearing upon the general trade position, inasmuch as the forward inquiries still fall short of what could be desired. Still, the tone all through the market is more cheerful, and it is possible that prices for prompt will go still higher. Best Northumberland steams are in a good position for the first half of May, and 17s. 3d. per ton is difficult to discount, while for prompt loadings 17s. 6d. is the minimum. Tyne primes and other special grades are also quoted more firmly at 16s. 9d. to 17s. The Durham gas coal trade position is also better. Best qualities are steady at 19s. 6d., and second grades command 17s. No improvement is reported in the coke trade. Stocks are far in excess of requirements, and values are weakly quoted.

SCOTLAND.

(From our own Correspondent.)

No Change.

No change is apparent in industrial circles generally. Apart from one or two sections in which a slight improvement is noticeable trade is extremely slow, and prospects are far from bright. Markets on the whole continue to weaken, while oncosts remain on a high level, and many producers complain that business, such as it is, cannot be termed remunerative, to say the least of it. In many instances stocks have grown to such an extent that cheap prices are offered to effect clearances. The measure of success meeting such efforts is most unsatisfactory, and as time progresses the situation becomes more serious.

Pig Iron.

The pig iron market is an extremely dull one. Home demands are very restricted, while the export turnover, though steady, is small in bulk. Stocks in makers' yards in many instances have become uncomfortably large, and the easing tendency of the market is largely due to this circumstance. Prices are unchanged from last week, but there is little doubt that a comparatively good order would receive especially keen terms for prompt delivery.

Steel.

It is as yet early to note any effect from the decontrol of steel prices. Business is so quiet that competition for considerable quantities of material is practically unknown at present, and consequently the market level is uncertain. It is said, however, that some, if not all, makers are ready to sell at from 5s. to 10s. per ton below former rates for average orders, and at still lower rates for substantial lots. The demand for the light description of materials is improving, particularly plates and sheets. Galvanised sheets, too, are busier again, and firm in price. Sectional steel is still slow, however.

Bar Iron.

No improvement is reported in the general demand for bar iron, and makers have considerable difficulty in maintaining employment. The recent reduction in price has brought out more inquiries for small quantities, but nothing substantial has been mentioned. Business in re-rolled steel has fallen away, despite a quotation of about £8 5s. per ton for home or export delivery.

Coal.

So far as the West of Scotland is concerned, the coal trade continues in a most unsatisfactory condition, and without evidence of improvement. Outputs have been further reduced during the past week, but stocks at pit heads are still considerably in excess of requirements, and the level of prices is easy. In Fifeshire and the Lothians, however, some increase in business is reported. Best Fife steams have firmed to 16s. per ton, and third-class qualities have also hardened a shade. The situation in the Lothians is perhaps more hopeful. Best steams are decidedly better off, and treble nuts also show a stronger front. As a rule, however, washed nuts are difficult to sell. Aggregate shipments for the week amounted to 252,548 tons, against 205,428 tons in the preceding week and 230,696 tons in the same week last year. While the improvement mentioned above is very welcome, exporters are loth to anticipate a continuance or development of the movement, in view of the keen competition arising from the exploitation of new coalfields in other countries. Fifeshire collieries have lost considerable orders owing to the electrification of railways abroad, notably in Denmark. The home market is weak at present and household fuels in particular are easier in price.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THERE has not been much change in the conditions prevailing in the steam coal trade since I wrote a week ago. The position of individual collieries has varied, but, taking it all round, nothing of any note has transpired to enable me to say that the conditions are materially better or that the outlook is brighter. It is true that the inquiry from some directions has become more active, but the volume of actual business carried through has not yet appreciably expanded. This is shown by the state of the docks, which in most cases are short of ready tonnage. The week was started with 20 tips idle and with only 13 steamers waiting for berths, so that it will be seen that the full working capacity of the docks is not being tested. Furthermore, the supplies of coal standing are fairly heavy in the case of some descriptions, and as a consequence of the failure of some collieries to secure the regular clearance of wagons, a number of pits are working intermittently. The outlook cannot by any means be described as encouraging, in view of the fact that the foreign demand is comparatively so meagre, while the news that the German Government has made a concession to mine owners of a 30 per cent. reduction in rail rates upon coal from the Ruhr to the North Sea and Baltic ports, will, if true, only serve to intensify the competition from that quarter, as the Germans will be enabled to cut their prices.

Diminished Italian Coal Requirements.

Coal shipments from this district to Italy were in normal times on a very considerable scale, but during the last twelve months they have fallen off substantially, and now comes the news that the Italian State Railway Agency at Cardiff is practically to be closed as from May 31st. This, following upon a similar decision recently come to in respect of the French State Railways' Cardiff Office, is somewhat depressing. The Italian State Railways, which also represent the Italian Navy, opened their Cardiff Office about seventeen years ago. Mr. Bellagama, who has been the manager since 1919, is returning to Italy. It is understood that as soon as the conditions are better and their requirements from this district expand, the Cardiff Office will be reopened, but that may not be for some considerable time as things are.

Coalfield Items.

Reference has been made to the decision come to that the miners in the No. 1 Rhondda district should give notices to terminate contracts on the non-unionist question, but it has now been made public that the prospects of there being trouble in the coalfield on this matter are somewhat remote owing to the fact that so many of the miners have ignored the instruction. At one or two of the more important collieries none of the workmen handed in notices, and at others only a minority of the miners carried out the decision. It is evident that the workmen are very reluctant to forfeit the work that is available in these times when employment is so precarious. It is also satisfactory to record that the notices which were given to the workmen at the Tydraw Colliery recently to terminate their engagements on account of the depression, have not become operative although they expired on Saturday last. The management has found it possible to carry on on day-to-day contracts. Hopes have been entertained that work would be resumed at the Blaenavon collieries, which have been idle for a month, but unfortunately they have not yet materialised.

Vauxhall Colliery Experiment.

There were developments last week regarding the somewhat strained relations between the men of the Vauxhall lodge and the North Wales Miners' Association, concerning the conditions under which work is being carried on at the colliery. The committee of the Vauxhall lodge has declined to apologise to the Association or to allow its delegate, Mr. J. T. Edwards, to withdraw from the guarantee bond, while the latter is stated to have said that if the men insist upon his remaining as a trustee to the fund he will stick to them. Some of the workmen have declared that they are now working six days a week, and that they would rather be turned out of the Association than go back on the existing scheme. Members of the North Wales Association have since been in London consulting the secretary of the Miners' Federation, and further developments are expected. Meantime it is interesting to note that half of the experimental period of three months expired on Tuesday of this week, and it is stated that both the management and the workmen are satisfied as regards the success of the scheme. The men are working full time with slightly increased hours and higher wages. Production has been steadily advanced and the £1000 guarantee fund has not so far been drawn upon.

Steel Trade.

It is reported that an order has been obtained for the supply of 10,000 tons of steel sheets for China and the Far East, and that the work is to be distributed among the steel works in this district, shipment being made at the Newport Docks. The Siemens furnaces at the Ebbw Vale Company's works have been closed down for an indefinite period, with the result that about 150 men have been added to the list of unemployed. The usual three-monthly ascertainment in the steel bar trade which regulates the wages in the South Wales Siemens steel works and the tin-plate industry shows a drop of 3½ per cent., the average price of bars during the first three months of this year being £7 18s. 11½d. per ton, as compared with £8 5s. 2¾d. in the preceding three months. The result is that the scale percentage declines from 7½ to 3¾ per cent. This is the second reduction in six months.

Dry Dock Extension.

Although the times in the dry dock and ship-repairing sphere are far from satisfactory, confidence in the future is shown by the fact that the Mountstuart Dry Docks and Shearmans, Ltd., are spending £30,000 on plant and extensions at the Eastern dry dock at Newport. The work of lengthening the dock has been in hand for some time, and, when completed, the dock will be able to accommodate vessels of approximately 425ft. in length by 54ft. beam.

Current Business.

Business has not expanded to any material extent during the past week, and has been relatively quiet. Prices have just about been maintained, but can scarcely be described as firm in any section. Superior second Admiralty large coals are comparatively better placed for orders than other descriptions, and the best Monmouthshire coals are well upheld, but inferior grades are in need of orders. Smalls are without appreciable change, and the demand for patent fuel and coke leaves room for marked improvement. Anthracite coals maintain a very good tone except duff and beans, which are in fair supply.

CATALOGUES.

NORTON COMPANY, Worcester, Mass., U.S.A.—Booklet entitled "The Balancing of Grinding Wheels."

W. H. WILLCOX AND CO., Ld., 38, Southwark-street, S.E. 1.—Folder dealing with Willcox-Friske greases.

BETHEL PLAYER AND CO., Limited, 17, Philpot-lane, E.C. 3.—Booklet on "Lapping and Lapping Machines."

MANLOVE, ALLIOTT AND CO., Limited, Nottingham.—Monthly wall calendar illustrating the "Manlove" drying room.

EWART AND SON, Ld., 346, Euston-road, N.W. 1.—Leaflet describing bath fittings coated with "Agate" enamel.

D. ANDERSON AND SON, Limited, Park-road Works, Stretford, Manchester.—Catalogue illustrating the "Belfast" roof.

RONALD TRIST AND CO., Limited, 12, Clipstone-street, W. 1.—Catalogue S 20, dealing with the "S. E. A. Ring" packings.

THE STANTON IRONWORKS COMPANY, Ld., Stanton, near Nottingham.—Monthly stock list of cast iron pipes for March, 1925.

THE INGLIS BOILER SYNDICATE, Ld., 83, Renfield-street, Glasgow.—Brochure on the "Inglis" patent land type steam boiler.

S. G. HEYWOOD AND COMPANY, Ld., Reddish, near Stockport.—Publication No. 18 dealing with a new design of electric block.

VICKERS-SPEARING BOILER COMPANY, Ld., 20, Kingsway, W.C. 2.—Revised edition of the Vickers-Spearing boiler catalogue.

GLOBE ENGINEERING COMPANY, Limited, 48, Watling-street, E.C. 4.—List No. 10 of standard direct-current motors and dynamos.

CAMBRIDGE INSTRUMENT COMPANY, Ld., 45, Grosvenor-place, S.W. 1.—Postcard describing the Cambridge dial thermometer.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Ld., Egyptian House, 170, Piccadilly, W. 1.—Pamphlet entitled "Boyer Pneumatic Tools."

SIR W. H. BAILEY AND CO., Ld., Albion Works, Salford, Manchester.—Catalogue illustrating and describing all types of Bailey's oil testers.

HERBERT HUNT AND SONS, Elsinore-road, Old Trafford, Manchester.—Catalogue illustrating and describing the Hunt system of twist drill manufacture.

RANSOMES AND RAPIER, Ld., 32, Victoria-street, S.W. 1.—Booklet entitled "Breakdown Cranes," illustrating and describing many types of railway breakdown cranes.

BRITISH STEAM SPECIALTIES, Ld., Fleet-street, Leicester.—Catalogue pertaining to fittings for use in connection with copper tubes. Suitable for pressures up to 300 lb.

AEROZONE AIR CONDITIONING COMPANY, Ld., Thornycroft House, Smith-square, S.W. 1.—Book illustrating and describing the Aerozone system of air conditioning as submitted to the National Physical Laboratory.

DELCO-REMY AND HYATT, Ld., 56 Victoria-street, S.W. 1.—I.N. 50 illustrating and describing tramcar axle boxes and electric traction motors fitted with Hyatt bearings. I.N. 52, entitled "Recommendations for the Lubrication of Hyatt Roller, and N. D. Ball Bearings."

PERSONAL AND BUSINESS ANNOUNCEMENTS.

CHARLES YATES AND CO., Ltd., of 26, Great St. Helens, London, E.C. 3, inform us that they have been appointed sole agents for Messrs. A. E. Metall. Nobels-Peelman, constructional engineers, of St. Nicolas (Waes), Belgium.

THE large public auction of Government surplus plant and machinery, by the George Cohen and Armstrong Disposal Corporation, is to be held on June 8th and 9th, and not on June 6th as previously announced.

WE are asked to state that the firm of John A. Smeeton, Ltd., 15, Victoria-street, Westminster, London, S.W. 1, has been appointed the sole agent for the Demag Company, as regards all rolling mill and other similar plant, and that Mr. T. Fearnley Allen, of 67, Norwich Union Chambers, Birmingham, is acting on Messrs. Smeeton's behalf for the Midland area.

I.E.E. WAR MEMORIAL BOOK.—Copies of the Institution of Electrical Engineers' War Memorial Book, to which we referred in our last issue, are obtainable by members and the public on application to the Secretary of the Institution, at the price of £2 2s. The proceeds are to go to the War Memorial Fund. A specimen copy of the Book can be seen in the library of the Institution.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	20/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	22/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 10 6	—
No. 1 Foundry	4 10 0	—
No. 3 Foundry	4 7 6	—
N.E. Coast—		
Hematite Mixed Nos.	4 2 0	4 2 0
No. 1	4 2 6	4 2 6
Cleveland—		
No. 1	4 2 0	4 2 0
Silicious Iron	4 2 0	4 2 0
No. 3 G.M.B.	3 17 0	3 17 0
No. 4 Foundry	3 16 0	3 16 0
No. 4 Forge	3 15 0	3 15 0
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 10 0 to 3 12 6	
,, Forge	3 7 0 to 3 8 0	
(3) Derbyshire—		
No. 3 Foundry	3 15 0 to 3 16 6	
Forge	3 10 0	—
(3) Lincolnshire—		
No. 3 Foundry	4 2 6	—
No. 4 Forge	3 17 6	—
Basic	4 0 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 13 6 (a) / 4 16 0 (b) / 5 1 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 12 6	—
Best ,,	—	—
N.E. Coast—		
Common Bars	11 12 6	—
Lancs.—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	13 0 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0	—
Gas Tube Strip	13 0 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	12 10 0	—
Ship Plates, ½in. and up	9 0 0	—
Sections	8 7 6	—
Steel Sheets, 3/16in. to ½in.	10 12 6	—
Sheets (Gal. Cor. 24 B.G.)	—	16 10 0 to 17 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 17 6	—
Angles	8 12 6	—
Boiler Plates	13 0 0	—
Joists	8 12 6	—
Heavy Rails	9 0 0	—
Fish-plates	13 10 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 10 0	—
Soft Billets	8 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 15 0†	—
Light ,,	9 0 0 to 9 5 0	
Billets	8 0 0 to 11 0 0†	
Manchester—		
Bars (Round)	9 10 0 to 10 0 0	
,, (others)	8 15 0 to 9 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	9 5 0	—
,, (Lancs. Boiler)	12 10 0	—
Sheffield—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 10 0	—
Intermediate Basic	9 0 0	—
Soft Basic	8 0 0 to 8 5 0	
Hoops	12 0 0	—
Soft Wire Rods	9 10 0 to 11 0 0	
Midlands—		
Small Rolled Bars	8 15 0 to 9 15 0	
Billets and Sheet-bars	6 17 6 to 7 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 12 6 to 16 15 0	
Angles	8 10 0 to 8 15 0	
Joists	8 10 0 to 8 15 0	
Tees	9 10 0 to 9 15 0	
Bridge and Tank Plates	9 10 0 to 9 15 0	
Boiler Plates	13 0 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	22/1½ to 22/4½
Block Tin (cash)	246 2 6
,, (three months)	248 5 0
Copper (cash)	61 7 6
,, (three months)	62 7 6
Spanish Lead (cash)	33 3 9
,, (three months)	32 13 9
Spelter (cash)	34 12 6
,, (three months)	33 12 6
Manchester—	
Copper, Best Selected Ingots	65 10 0
,, Electrolytic	66 10 0
,, Strong Sheets	91 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis price)	0 0 11½
,, Condenser	0 1 2
Lead, English	35 15 0
,, Foreign	34 10 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/-
,, 6 p.c. to 8 p.c. ,,	£23 5 0	7/9
,, 8 p.c. to 10 p.c. ,,	£23 0 0	7/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£43 0 0	15/6
,, ,, 1 p.c. ,,	£52 0 0	17/-
,, ,, 0.70 p.c. carbon	£57 10 0	19/-
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 15 0 unit	scale 5/- per
,, ,, 75 p.c.	£22 0 0 unit	scale 6/- per
,, Vanadium	17/- per lb	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/- per lb	
Nickel (per ton)	£175	
Cobalt	10/3 per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	15/3
,, ,, Ell	16/3
,, ,, Splint	17/- to 19/6
,, ,, Trebles	14/9
,, ,, Doubles	13/9
,, ,, Singles	13/3
Ayrshire—	
(f.o.b. Ports)—Steam	15/6
,, ,, Splints	17/6
,, ,, Trebles	14/9
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	13/10½ to 16/-
Screened Navigation	21/9
Trebles	15/9
Doubles	13/10½
Singles	13/3
Lothians—	
(f.o.b. Leith)—Best Steam	15/9
Secondary Steam	15/-
Trebles	16/3
Doubles	14/-
Singles	13/6

ENGLAND.

(8) N.W. Coast—	
Steams	27/-
Household	45/- to 58/4
Coke	28/-
Northumberland—	
Best Steams	17/3 to 17/6
Second Steams	16/6
Steam Smalls	11/- to 11/6
Unscreened	15/6 to 16/6
Household	23/6 to 25/-
Durham—	
Best Gas	19/6 to 19/9
Second	17/- to 17/3
Household	23/6 to 25/-
Foundry Coke	21/6 to 22/6

Sheffield—	Inland.	
Best Hand-picked Branch	30/- to 33/-	—
Barnsley Best Silkstone	26/- to 27/-	—
Derbyshire Best Brights	26/6 to 29/6	—
,, ,, House	24/- to 26/-	—
,, ,, Large Nuts	20/- to 24/-	—
,, ,, Small	14/- to 16/-	—
Yorkshire Hards	18/- to 22/-	—
Derbyshire ,,	18/6 to 22/-	—
Rough Slacks	10/- to 12/6	—
Nutty ,,	8/6 to 10/-	—
Smalls	3/6 to 5/6	—
Blast-furnace Coke (Inland)*	—	—
,, ,, (Export)	f.o.b.	21/3 to 22/3

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	26/- to 26/6
Second ,,	25/- to 26/-
Best Dry Large	25/- to 25/6
Ordinary Dry Large	23/6 to 24/6
Best Black Vein Large	24/- to 24/6
Western Valley ,,	23/- to 24/-
Best Eastern Valley Large	23/- to 24/-
Ordinary ,, ,,	22/6 to 23/-
Best Steam Smalls	15/6 to 16/-
Ordinary ,,	13/- to 15/-
Washed Nuts	20/- to 28/-
No. 3 Rhondda Large	27/- to 27/6
,, ,, Smalls	17/- to 18/-
No. 2 ,, Large	22/- to 22/6
,, ,, Through	18/- to 20/-
,, ,, Smalls	12/- to 13/6
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	25/- to 30/-
Patent Fuel	23/- to 26/-
Pitwood (ex ship)	23/- to 23/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	44/- to 46/-
Seconds	38/- to 40/-
Red Vein	29/- to 32/-
Machine-made Cobbles	50/- to 55/-
Nuts	50/- to 55/-
Beans	38/- to 42/-
Peas	22/6 to 23/6
Breaker Duff	8/9 to 9/-
Rubbly Culm	12/6 to 13/-
Steam Coals:	
Large	21/- to 24/-
Seconds	20/- to 21/-
Smalls	10/- to 13/-
Cargo Through	16/- to 19/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/9, with fluctuations according to analysis; open market, 18/- to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Trade Restriction.

THE present industrial stagnation is not so much the result of a decline of business as of a temporary suspension of activity produced by the feeling of uncertainty that exists regarding the situation generally. There is still a great deal of work being carried out in France and much more remains to be done, but so long as capital is rendered timid by the financial propositions, the money available for executing the works is extremely small, and the orders given out are limited to what is strictly necessary. These contracts are usually sufficient to provide fair employment to engineering shops, although in most cases the number of hands has been reduced, and the situation becomes critical when it is seen that as the orders are worked off there is little immediate promise of their being replaced. It is therefore becoming very urgent that the financial difficulties should be cleared away so that capital will be available for industrial undertakings. There has been a question of raising heavy foreign loans, principally in the United States, for the carrying out of the vast hydro-electric and other schemes in contemplation, but under present conditions there seems very little prospect of the Americans rendering financial aid. Capitalists at home are allured more particularly by building investments, and this fact, of course, helps business to a large extent. As they refuse to embark upon industrial ventures it is hardly to be expected that foreign capitalists will display more confidence than they themselves are showing. Evidence of the general inactivity is observable in the stagnation of the iron and steel trades, which have rarely been so quiet as they are at the present moment. In the absence of buying, the recent constitution of a group for maintaining minimum rates has alone prevented a decline of iron and steel prices.

Naval Construction.

The credits for putting in hand the vessels which are to complete the second part of the programme of naval construction have been voted, so that the work will be continued during the present year without interruption. It has been pointed out that it would be quite impossible at present to bring troops from North Africa in face of a hostile navy of even second rate power, and that the French naval policy aimed exclusively at defending the Mediterranean route and rendering the coast as far as possible inviolate. The arguments put forward to show the weakness of the French Navy are, of course, perfectly sound when applied to capital ships, but the country relies more particularly upon light and fast cruisers, submarines and seaplanes, and the development of the submarine and aviation services is certainly being pushed forward as rapidly as possible. It is declared that the submarines surrendered by Germany are very defective, because they were hurriedly constructed during the war. Although the country's naval policy is stated to be one of home defence with the aid of light craft and seaplanes, it is not likely to be made clear how the defence will be organised until the Naval Statute comes up for discussion, when special attention will be given to the co-operation of the aviation service with the fleet.

Paris Water Supply.

The various schemes that have been put forward to provide Paris with an adequate water supply continue to be the subject of investigations and reports of a conflicting character, and the latest pronouncement is strongly against the proposal to bring water from the huge reservoirs which it is proposed to construct in the upper reaches of the Seine, with the idea of correcting the considerable variations of the river level during the wet and dry seasons. It is argued that it would be a costly undertaking to bring the water to Paris from such long distances, and the cost would only be justified in the event of the supply being sufficiently pure to dispense with the necessity of filtration. As, however, the water stored in the reservoirs is not expected to be much better than the supply obtainable from the Seine above Paris, it is suggested that the city may, after all, be obliged to rely upon the filtration of river water, unless the difficulties being encountered in bringing supplies from the Vals de la Loire are overcome. The population of the Loire Valley is, however, so strongly opposed to the underground water being pumped to Paris, that it is becoming more and more doubtful whether the project will ever be carried out. If Paris has to depend entirely upon the Seine and Marne for the considerable supplies necessary for the needs of a rapidly growing population, it is feared that it will have a serious effect upon navigation. Meanwhile, the problem is becoming so urgent that no time can be lost in providing a solution.

Railway Electrification.

The electrification of the Midi railway system is being proceeded with rapidly, and already electric trains are running between Toulouse and Dax and on the lines to Pierrefitte, Bagnères-de-Bigorre and Arreau. During the summer an electric service will be run to Luchon. The electrification is completed between Dax and Hendaye, and before the end of the year it is probable that the line will be equipped between Dax and Bordeaux and Arcachon. Progress is only retarded by the delays in procuring the necessary rolling stock. There are at present under construction 55 electric locomotives and 15 electric motor coaches. The Hourat generating station in the D'Ossau Valley will be put into operation very shortly, and work will soon be started upon the installation of the turbines at Miégebat.

"The Joy Stick."

Having succeeded in obtaining a judgment in his favour against French makers for infringement of his patent for the "joy stick" control of aeroplanes, M. Esnault-Pelterie took action in the French Courts against a number of British firms. In this case he has not been successful, for the Court declared that the English builders of aeroplanes merely executed orders from the British Government, and that French Courts had no jurisdiction over a foreign State. Moreover, the orders were executed during the war "in the public interest."

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

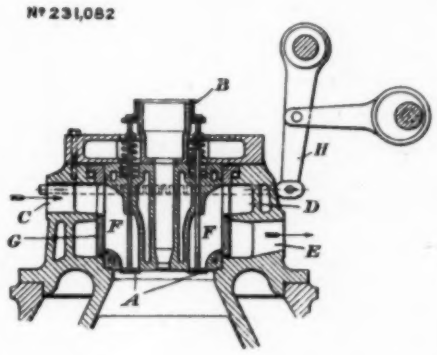
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

231,082. September 15th, 1924.—CYLINDER HEADS, C. Zulver, 8t. Helen's-court, Great 8t. Helen's, London, E.C. 3, and G. J. Lugt, de Lairessestraat 66, Amsterdam, Holland.

The inventors naïvely remark that the "cylinder head of an internal combustion engine, more especially for a Diesel engine, is very difficult to design and make in such a manner that defects do not eventually develop." In order to overcome this trouble they propose to utilise a large number of comparatively small distributing valves on account of their smaller liability to distortion, under working conditions. Incidentally, the same valves are used for the induction and the exhaust of the gases. These valves A A are actuated by their stems being connected with the collar B, which, in turn, is appropriately operated. The gas inlet C is continued round the cylinder head in the form of an annular passage D, as is also the exhaust E. Between these annular passages and the ports F F there is a rotary sleeve valve G. This valve is oscillated by the mechanism H, and is used to put the ports F F alternately in connection with the inlet and the exhaust.—*March 26th*, 1925.

N° 231,082

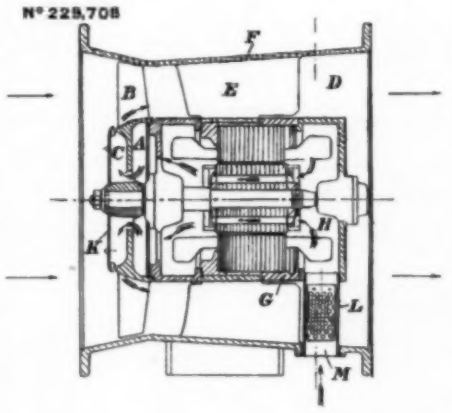


DYNAMOS AND MOTORS.

229,708. February 23rd, 1925.—IMPROVEMENTS IN OR RELATING TO ELECTRICALLY DRIVEN FANS, Société Rateau, of 40, Rue du Colisée, Paris, France.

This invention relates to electrically driven fans, and has for its object an improved method of mounting an electro-motor for driving a fan. Arms A form part of a fan rotor, having vanes B. Auxiliary vanes C intended for ventilating the motor are mounted on the arms A. Around the stator is a diffuser D, which may be provided with guiding partitions E. A casing F, which surrounds the vanes B of the fan and the diffuser D, may be attached to the delivery conduit of the fan. The shell G of the stator is cooled by contact with the fluid traversing the diffuser D. The auxiliary vanes C draw air through air spaces in the motor, and thus contribute to the cooling of the latter. The rotor and stator of the motor may be provided with passages H for air circulation. The air delivered by the auxiliary vanes C is preferably directed by means of a wall K towards the vanes B of the main fan, in such a manner that a portion of its residual velocity is utilised partially for assisting the suction of the latter. The air or other fluid may be drawn into the motor through spaces bounded by walls L between which are arranged perforated partitions M for keeping back dust or other impurities present in the fluid.—*March 26th*, 1925.

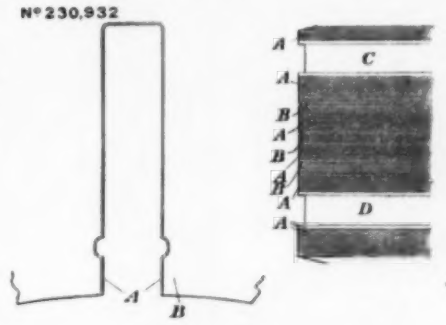
N° 229,708



230,932. December 21st, 1923.—IMPROVEMENTS IN THE LAMINATED CORES OF ELECTRICAL MACHINES, The English Electric Company, Ltd., Alexander Drew Sloan, and Frederick Albin Youngmark, all of 28, Kingsway, London, W.C. 2.

The laminations of which a core is made in accordance with this invention are of two kinds, in one of which the slots are slightly wider and are also preferably deeper than in the other kind. The laminations A are of normal configuration, whilst those shown at B have slots slightly wider and deeper than those in the other laminations. Radial air ducts C and D are provided with the usual distance plates, and between these ducts is a packet of laminations divided into four groups by means of the laminations B. It will be seen that the core is built up from the two kinds of laminations in such a manner that the centre lines of the slots are approximately coincident throughout. The edges of the laminations having the wider slots stand slightly behind the line of the edges of the slots in the laminations of the other kind, so that in a filing or similar operation carried out on the built-up core, only the edges of the latter kind of laminations will be materially acted upon, and any burring which may be produced will not bridge over the other laminations.—*March 23rd*, 1925.

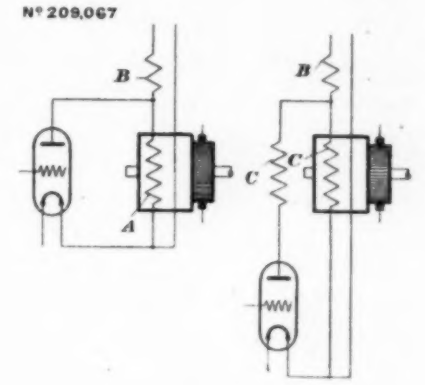
N° 230,932



209,067. December 18th, 1923.—IMPROVEMENTS IN OR RELATING TO MEANS FOR REGULATING DIRECT-CURRENT ELECTRIC MACHINES, Siemens-Schuckertwerke Gesellschaft mit beschrankter Haftung, of Siemensstadt, Berlin.

As shown in the left-hand diagram, a thermionic valve is shunted across the field winding of a direct-current motor, the object being to maintain the speed of the machine constant. The tension on the grid can be influenced by a small dynamo driven by the motor, but this is not shown in the drawing.

N° 209,067



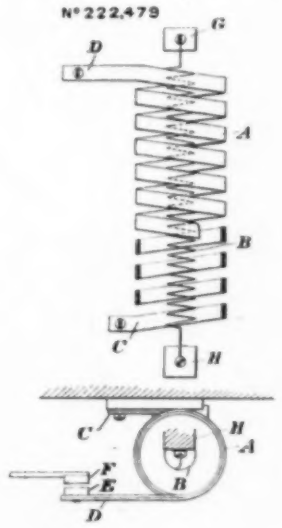
When the tension on the grid rises above a given value, the exciting current, instead of flowing through the winding A, flows through the valve from the anode to the cathode, and the resistance B limits the current intensity. The right-hand diagram shows an example of the invention, in which the exciting current flows partly through the resistance C and from the anode to the cathode, the valve only acting as a shunt to the exciting winding when the charge on the grid of the valve exceeds a certain value.—*March 18th*, 1925.

SWITCHGEAR.

222,479. September 23rd, 1924.—IMPROVEMENTS IN ELECTRIC THERMAL SWITCHES, *The International General Electric Company, Incorporated, of* 120, *Broadway, New York, U.S.A.*

A bi-metallic strip A is helically coiled and within this coil is a heating coil B. The lower end C of the strip A serves for securing the coil in position, whilst the upper end D serves for connecting the two contacts E and F. The heat from the inner coil is transferred almost without loss to the bi-metallic strip which encloses the heating coil. The terminals for the heating coil are shown at G and H.—*March 26th*, 1925.

N° 222,479

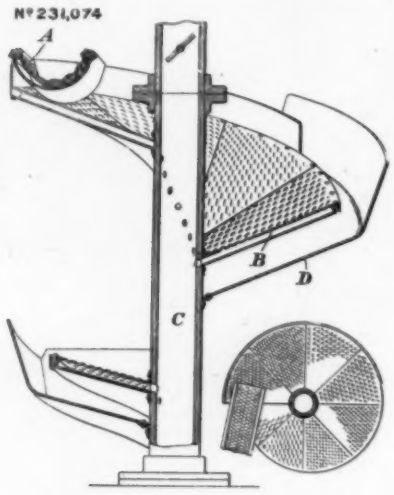


MINING MACHINERY.

231,074. August 13th, 1924.—COAL SCREENS, *W. J. Underwood, 70, Chancery-lane, London, W.C. 2.*

This apparatus, for separating coal from slate and shale, is of the spiral type, in which some dependance is put upon the relative frictional resistances of the materials for their separation under the influence of centrifugal force. Its action is, however,

assisted by an air blast. The dirty coal is fed down the shoot A into a spiral conveyor which has a hollow floor B. Into this hollow a blast of air is led from the central supporting column C and issues from the perforations shown. The result is, it is

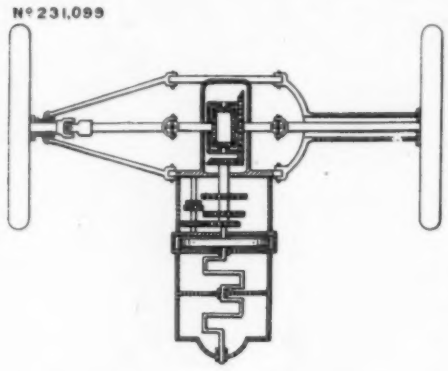


claimed, that the coal, having a glossy surface, spills out over the edge of the spiral floor B and is caught in the trough D, while the shale, with its comparatively dull texture and greater density, follows the spiral downwards and is discharged separately.—*March 26th*, 1925.

MOTOR CARS AND ROAD TRAFFIC.

231,099. October 29th, 1924.—REAR AXLES, E. Rumpler, 100, Friedrichstrasse, Berlin, N.W. 7, Germany.

According to this invention a rear axle drive for mechanically propelled vehicles comprises in combination half axle parts, upon the outer ends of which the respective rear wheels are mounted; a shaft connecting each half axle part to the respective driving shaft of the differential gear through one or more Cardan joints; a thrust member or members for each half-axle part, pivoted, on a horizontal axis passing through the axis of the Cardan joint adjacent the differential gear, to a fixed part

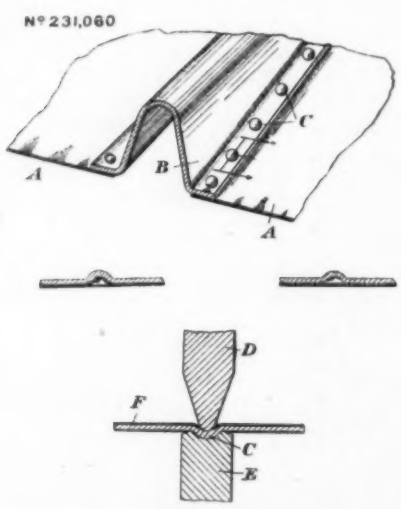


or parts of the vehicle; and an engine disposed adjacent to or upon the rear axle assembly and driving the differential gear, either directly or through variable speed gearing. By this arrangement the loads upon the rear axle remain practically constant, so that when the vehicle is lightly loaded the wheels cannot slip, and, furthermore, the total weights are placed nearer to the point of oscillation of the vehicle, so that the accelerating forces which are produced upon the vehicle passing over an obstacle, and which cause the oscillation of the vehicle, are rendered less effective.—*March 26th*, 1925.

WELDING.

231,060. July 17th, 1924.—IMPROVEMENTS IN ELECTRIC WELDING, *Frank Bernhard Dehn, of 53, Doughty-street, London, W.C.* 1.

The object of this invention is to overcome the difficulty that

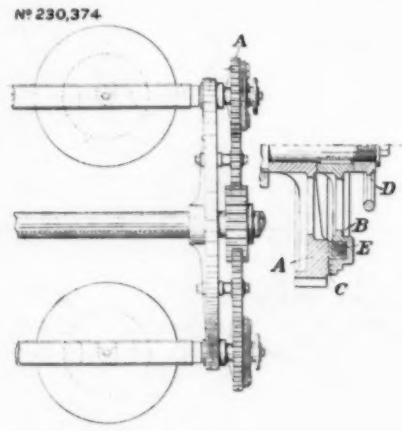


has hitherto been experienced in the spot welding of metal pieces or sheets which differ considerably in thickness. The invention aims at welding together pieces of metal without giving rise to wrinkling or buckling, and another object is to provide a strong and lasting welded joint. The drawing shows two relatively thin sheets of metal A, which are welded to a reinforcing rib B, which is composed of considerably thicker metal. Depressions C are pressed in the flange portion of the plate B, which is then supported between two electrodes D and E of an electric spot welding machine, so that the convex surface of one of the depressions rests in the concave seat formed in the upper end of the electrode D. The edge of the thinner sheet of metal F is then inserted in the manner shown. The flow of current between the electrodes and through the pieces of metal cause the latter to melt at the parts where the electrodes engage and the pressure with which the electrode D bears upon the work forces the metal of the thin sheet down into the depression C, and at the same time forms a spot weld.—*March 26th*, 1925.

MISCELLANEOUS.

230,374. September 25th, 1924.—STRANDING MACHINES, W. O. Larmuth, Todleben Ironworks, Union-street, Salford.

This invention is concerned with the gear used on wire cable stranding machines to prevent the cradles carrying the bobbins from rotating with the main cage. When strands are being made of wire having a section other than round it is necessary to adjust the positions of the cradles accurately, otherwise the wires will not lay up together properly. For this reason the gear wheel A



is loose on the cradle trunnion, but can be connected with it by means of the coupling B. This coupling is furnished with teeth C that mesh with corresponding teeth on the gear wheel. If the hand wheel D is slacked off the coupling will be pushed out of mesh by the springs E and the two parts can then be turned, relatively to one another, to adjust the position of the cradle The hand wheel is, of course, then tightened up again.—*March 12th*, 1925.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY AND SATURDAY, MAY 2ND.

LOCAL INDUSTRIES EXHIBITION.—At Drill Hall, Church-hill, Walthamstow, London, E. 17. 10.30 a.m. each day.

VICKERS' WESTMINSTER AMATEUR OPERATIC SOCIETY.—New Scala Theatre, Tottenham Court-road, Charlotte-street, W. 1. Performance of the comic opera "Merrie England." 8 p.m. each evening.

TO-DAY.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.—Prince's Hall, Hotel Cecil, London, W.C. 2. Annual smoking concert. 8 p.m.

INSTITUTE OF COST AND WORKS ACCOUNTANTS.—Hotel Great Central, Marylebone-road, London, N.W. Fourth annual Costing Conference. 10.30 a.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "Pumps and Pumping Problems," by Mr. A. A. Fairfax. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Annual meeting. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Crystalline Structure of Inorganic Salts," by Professor W. L. Bragg. 9 p.m.

SATURDAY, MAY 2ND.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—College of Technology, Manchester. Lecture, "The Importance of Venting, with special reference to Defective Castings," by Mr. E. Longden. 4 p.m.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.—Cannon-street Hotel, London, E.C. 4. Seventy-second anniversary festival. 6.20 p.m.

MONDAY, MAY 4TH.

ROYAL COLLEGE OF SCIENCE ASSOCIATION.—Chemical Lecture Theatre of the Royal College of Science, Exhibition-road, London, S.W. 7. Huxley Lecture, "Thomas Henry Huxley," by Professor E. B. Poulton. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. General meeting of members. 5 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London W.C. 2. Howard Lecture. "Motor Fuels—III.," by Professor J. S. S. Brame. 8 p.m.

SOCIETY OF ENGINEERS.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Paper, "Water Power Exhibits at the British Empire Exhibition, Wembley, 1924," by Mr. R. C. S. Walters. 5.30 p.m.

SURVEYORS' INSTITUTION.—12, Great George-street, Westminster, London, S.W. 1. Paper, "New Methods of House Construction," by Major Harry Barnes. 8 p.m.

TUESDAY, MAY 5TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Thirty-first James Forrest Lecture, "Heavy-Oil Engines: Some Outstanding Questions relating to Large Engines of the Self-ignition Type," by Captain H. Riall Sankey. 6 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Some Notes on Water Shut-off," by Mr. F. G. Rappoport. 5.30 p.m.

WEDNESDAY, MAY 6TH.

INSTITUTE OF METALS.—Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W. 1. Fifteenth Annual May Lecture on "The Motion of Electricity in Metals," by Professor Dr. H. A. Lorentz. 8 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Joint meeting with the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institution of Naval Architects, the Institute of Marine Engineers, the North-East Coast Institution of Engineers and Shipbuilders, the Institution of Engineers and Shipbuilders in Scotland, the Institute of Chemistry of Great Britain and Ireland, the Institution of Gas Engineers, the British Electrical and Allied Manufacturers' Association, the British Engineers' Association, the Admiralty, the War Office, and the Air Ministry, which are co-operating in the work of the Special Committee on Tabulating the Results of Heat-Engine Trials. Discussion, "A Standard Code for Tabulating the Results of a Heavy-Oil Engine Trial," submitted by Mr. J. Carnaghan. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. "Report on Measurements made on Signal Strength at Great Distances during 1922 and 1923 by an Expedition sent to Australia," by Captain H. J. Round, Messrs. T. L. Eckersley, K. Tremellen, and F. C. Lunnon. 6 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "Commercial Aviation," by Air Vice-Marshal Sir W. Sefton Brancker. 8 p.m.

THURSDAY AND FRIDAY, MAY 7TH AND 8TH.

IRON AND STEEL INSTITUTE.—Institution of Civil Engineers, Great George-street, London, S.W. 1. Annual meeting. For programme, see page 411. 10 a.m. each day.

FRIDAY, MAY 8TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Fourth Report of the Steam Nozzles Research Committee. 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South Wales District meeting. 1.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Circulation of Blood in the Capillary Vessels," by Dr. H. H. Dale. 9 p.m.

SATURDAY, MAY 9TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Eastern District meeting at Worthing. 11.15 a.m.

SATURDAY, MAY 16TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Visit to the works of Leyland Motors, Ltd., Leyland, near Preston. 3 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Western District meeting at Tiverton. 11 a.m.

CONTRACTS.

HOWDEN-LJUNGSTROM PREHEATERS (LAND), Ltd., have received an order to supply to the Ransome and Marles Bearing Company, Ltd., Newark-on-Trent, a preheater having a total heating surface of 21,500 square feet. Air is to be supplied to the furnace at about 360 deg. Fah.

THE VICKERS-SPEARING BOILER COMPANY, Ltd., 20, Kingsway, London, W.C. 2, has secured a contract for water-tube boilers through Messrs. Kennedy and Donkin, consulting engineers for the Calcutta Electric Supply Corporation, Ltd. The contract includes buildings and complete equipment.

BRITISH SEPARATORS, Ltd., of 161, Queen's-road, Peckham, London, S.E. 15, inform us that the motor vessel which is being built by the Fairfield Shipbuilding and Engineering Company, Ltd., for Messrs. Houlder Brothers will be fitted with "Vickeen" oil purifiers for the purification of both fuel oil and lubricating oil for the main Diesel engines.

ALFRED HERBERT, Ltd., Coventry, have received a further order from the Amsterdam electricity authorities for the supply of four large Atritor unit pulverisers, each capable of pulverising 6000 lb. of bituminous coal per hour. These machines will fire a large Clayton water-tube boiler, having a normal evaporation of 154,000 lb. of water per hour to a pressure of 45 atmospheres (662 lb. per square inch) and superheated to 375 deg. Cent. (707 deg. Fah.).

THE MIRRLEES WATSON COMPANY, Ltd., of Glasgow, has just received an order for two surface condensing plants from the British Thomson-Houston Company, Ltd., Rugby, which is supplying the turbines for two 6000-kilowatt plants for the Southern power station, Garden Reach, Calcutta. Each condenser is for dealing with 75,000 lb. of steam per hour under a vacuum of 28in. while circulating 10,000 gallons per minute of cooling water through tubes giving a total cooling surface of 11,000 square feet.

STOTHERT AND PITT, Ltd., of Bath, have received an order from the Mersey Docks and Harbour Board for twenty-seven electric jib cranes of their latest patented crank-operated horizontal luffing type. Nineteen cranes will have a lifting capacity of 3 tons at 74ft. 9in. radius, or 1½ tons at 85ft. 9in., and the eight other cranes will deal with 1 ton at 48ft. 6in. radius. These twenty-seven cranes, together with thirty-one similar cranes which the firm is now building, will form the complete crane equipment of the new Gladstone Dock.

NEW TYPE OF ROAD SWEEPER, SPRINKLER AND COLLECTOR.—Our attention has been called to an obvious misprint in the last line of the description of the new type of combined road sweeper, sprinkler and dust collector, recently introduced by Karrier Motors, Ltd., of Huddersfield, which appeared on page 441 of our issue of April 17th. The cost of operating the vehicle is given as being ½d. per mile run. The figure should, of course, have been 1s. 3d.